THURSDAY, JUNE 16, 1892.

## MECHANICS.

*A Treatise on Analytical Statics.* With numerous Examples. Vol. I. By Edward John Routh, Sc.D., LL.D., F.R.S., Hon. Fellow of Peterhouse, Cambridge; Fellow of the Senate of the University of London. (London: Macmillan and Co., 1891.)

*The Elementary Part of a Treatise on the Dynamics of a System of Rigid Bodies.* Being Part I. of a Treatise on the Whole Subject. With numerous Examples. By the Same. (London: Macmillan and Co., 1891.)

WITH these two volumes the mathematical student is completely equipped for the course of Analytical Mechanics, as required for Part I. of the Cambridge Mathematical Tripos.

A second volume is promised of the "Analytical Statics," to cover the parts in Attraction, Astatics, and the Bending of Beams; and this, in conjunction with Part II. of the "Dynamics," will complete his library for the second part of the Mathematical Tripos, according to present regulations.

The great feature of these works is the very complete collections of examples which the author has brought together with great labour, and enriched with many of his own invention, fit to rank among the theorems of the science, rather than as mere problems.

The author is of the opinion that in order to learn Mechanics it is essential to the student to work many examples, taken as far as possible from questions that have actually arisen.

In this opinion he agrees with Fourier, who says:—

"L'étude approfondie de la nature est la source la plus féconde des découvertes mathématiques. Non seulement cette étude, en offrant aux recherches un but déterminé, a l'avantage d'exclure les questions vagues et les calculs sans issue; elle est encore un moyen assuré de former l'Analyse elle-même," &c.

This is an opinion, however, that has always divided mathematicians into rival camps, and we find Jacobi remonstrating with these words of Fourier by retaliating:—

"Il est vrai que M. Fourier avait l'opinion que le but principal des mathématiques était l'utilité publique et l'explication des phénomènes naturels; mais un philosophe comme lui aurait dû savoir que le but unique de la science c'est l'honneur de l'esprit humain; et que sous ce titre, une question de nombres vaut autant qu'une question du système du monde."

The developments of mathematics are now so great that specialization is a necessity, so that these rival theories need not come into collision; and the pure mathematician may allow the writer on Mechanics to treat of what the name of the subject implies without being compelled to regard his own Geometry as mere Land-Surveying, according to the strict meaning of the word.

There is a tendency in operation among certain mathematicians, as illustrated by Poincaré's remarks on Maxwell's writings, to degrade mathematical argument to mere Calcul, by reducing the experimental facts on which the theory is based to the barest minimum, and that not always clearly established (we venture to instance the Newtonian Law of Universal Gravitation). A vast array of Analysis is in consequence balanced upon a very small amount of axiomatic experiment, which in many cases the smallest divergence of experimental fact is sufficient to upset.

We had hoped at the outset that Duchayla's proof of the Parallelogram of Forces had disappeared, never to reappear again, but it unfortunately pops up on p. 16.

Considering that Static leals with the Equilibrium of Bodies would make a great simplification if the word Resultant was abolished, unless when required to mean a single force reversed of a system of equilibrating forces.

In this way a much simpler proof of the Parallelogram of Forces can be constructed, as indicated by Prof. Maxwell in the Mathematical Tripos; and one figure will now serve for all the possible cases arising in the equilibrium of three parallel forces (p. 47).

Again, when the system is in equilibrium, there is no need to introduce the restriction that the bodies are *rigid* (p. 12); the conditions are precisely the same for elastic bodies; but the system having come to rest, the parts are of invariable form. Every structure (the Forth Bridge, for instance) is composed of elastic parts, but the theorems of elementary Statics are still applicable in the investigation of the principal stresses.

Again, by considering balancing couples, the refined theorems concerning the equivalence of couples in the same or parallel planes, and the composition of couples in different planes, are rendered much more convincing.

In accordance with its title of "Analytical Statics," the theorems concerning the composition and equilibrium of forces in space are treated with reference to co-ordinate axes; but Sir Robert Ball's purely geometrical conceptions of the Wrench, Screw, and Cylindroid are introduced, and discussed from a fundamental standpoint.

A chapter on the determination of Centre of Gravity appears in all treatises on Analytical Statics, just as works on Rigid Dynamics begin with a long and tedious chapter on Moments of Inertia: these subjects should form part of the ordinary treatises on Integral Calculus, and so relieve treatises on Mechanics from at least the principal elements of such calculations.

In the application of the Barycentric Calculus to geometry, the author has made a very interesting collection of problems, well calculated to illustrate the power of this method.

The principal theorems of Statics involve profound geometrical argument, and consequently prove difficult to the majority of students, whose proclivities are usually analytical; but in the applications to Catenaries the analytical interest comes again to the front. Considering that the hyperbolic functions can now be obtained tabulated numerically—for instance, in a table by Mr. T. H. Blakesley, published by the Physical Society—it is curious that the author does not employ them in the discussion of the ordinary Catenary, where their use introduces great elegance and simplicity into the analysis. The figure of the Catenary on p. 316 might with advantage be redrawn, so as to exhibit accurately the principal properties of this curve.

Again, in Example 6, p. 352, where the problem of

the catenary is discussed under a central attraction or repulsion, varying inversely as the square of the distance, when the hyperbolic functions are used in conjunction with the circular functions, we are able to write the equation of the catenary in the form—

$$l/r = 1 + \sec\alpha\cos(\theta\sin\alpha), \text{ or } 1 + \operatorname{sech}\alpha\cosh(\theta\sinh\alpha),$$

including all possible cases; and it is a curious geometrical result that if these curves are rolled on a straight line, the pole will always describe a circle.

The treatment in § 500 of the catenary curve formed by an elastic rope can also be rendered more elegant by the introduction of the hyperbolic functions.

The chapter relating to Catenaries is headed "Strings." But *string* is used only for tying up parcels; we use a *rope* or *chain* in full scale mechanics, and *thread* in a model; the word *thread* should be used when its own weight is to be neglected, and the words *rope* or *chain* when applied to a true catenary.

A short chapter on Graphical Statics is very welcome, and might with advantage be further developed; and the final chapter, on Machines, is of the usual academic character. The interest of this chapter would be much increased if the diagrams, particularly of the Balance and of the Differential Pulley were taken from objects actually in existence.

The author never employs the absolute units of force, the *poundal* or *dyne*, which he has defined in Chapter I., but works throughout with the gravitation unit. This is in accordance with the universal practice; and to satisfy legal and commercial requirements, these absolute units would require to be defined through the intermediate of the gravitation unit, by taking them as one-$g$th part of the tension of a thread supporting a pound or gramme weight, the value of $g$ being determined from pendulum experiments. There is no apparatus in existence by which the theoretical definition of the poundal and dyne, derived from dynamical phenomena, could be tested with any pretence to accuracy.

The dyne is the unit of force in the C.G.S. system, but it is a great pity that the commercial units, the metre and the kilogramme, were not adopted; the unit of energy would then be the *joule*, and the unit of power the *watt* or *volt-ampere*. Merely, apparently, for the purpose of making

$$W = sV, \text{ instead of } 1000sV,$$

the Committee of the British Association recommended these niggling C.G.S. units; but considering that for ordinary substances, metals, &c., variations of texture render it unnecessary to tabulate densities beyond four significant figures, the factor 1000 is a positive advantage in numerical calculations, as $1000s$ may be replaced by a whole number.

The "Analytical Statics" is a completely new work, but Dr. Routh's "Dynamics of Rigid Bodies" has been the text-book in universal use for thirty years or more, a better testimony to its merits than anything that could be said here.

It is a pity that a sufficient working knowledge of the simple ideas of Moment of Inertia is not given in a course of the Integral Calculus, so that the author might start immediately on some familiar problems of the motion of a body which turns as well as advances, and relegate the bulk of Chapter I. to a later chapter, when the motion of bodies in space is considered. This long chapter at the outset chokes off many students, who would be encouraged if the principles were introduced in smaller doses, and only as required. The gentlemanly knowledge of this subject, as Maxwell called it, which does not go beyond motion in a plane, is a very valuable mathematical training, and few students go beyond this stage.

D'Alembert's Principle is historically important, as a first clear statement of the mode of forming the equations of motion; but now, in accordance with the modern principle of considering the Third Law of Motion, "Action and Reaction are equal and opposite," as defining a stress composed of two equal opposite balancing forces, D'Alembert's Principle should now be merely looked upon as a convenient mode of writing down the equations of Dynamics in an analytical statical form, when stated in the words, "The reversed effective forces and the impressed forces form a system in equilibrium," while "the molecular, cohesive, or internal forces form a system in equilibrium among themselves."

The much-abused word "centrifugal force" still survives, and need not cause confusion if used to denote the normal component of the reversed effective force of a body moving in a curve.

Early methods of argument in Dynamics were very similar to what we now employ in Thermodynamics, in the statement of the Second Law.

Sir George Airy's commentary on D'Alembert's Principle, quoted on p. 52, forms a very curious contrast to the corresponding explanation in Maxwell's "Matter and Motion."

It would be a strange skeleton frame that Sir George Airy would have had to create to propagate the attraction between the Earth and the Moon or Sun; and an interesting subject of speculation arises as to the modification of Newton's Law of Universal Gravitation when the inertia of the skeleton frame became appreciable.

The discussion on the Pendulum is very complete; Kater's pendulum is fully described, but we miss the account of Repsold's pendulum. In this pendulum the effect of the drag of the air is eliminated by making it symmetrical in shape, but unsymmetrical in density. A short account of Repsold's pendulum will be found in the Account of the Great Trigonometrical Survey; but the pendulum is obviously looked upon with suspicion by our officers, as being employed by their Russian rivals on the other side of the Himalayas.

The very perfection of the pendulum as a method of determining $g$ is the cause of its defect as a means of recovering the standard of length, so that equally skilled observers would differ to an appreciable extent if set to work to reconstitute the standard yard from the seconds pendulum; the clause in the Act of Parliament defining the length of the seconds pendulum is in consequence superfluous.

There is something mysterious and unconvincing in § 109, on the "Oscillation of the Watch Balance"; considering that the inertia of the spring itself is neglected, it seems that the final equation of oscillation might well be written down immediately, without the introduction of any approximation.

The Ballistic Pendulum and its theory are fully de-

scribed; but it should be pointed out that the pendulum in which the gun itself is mounted gives very untrustworthy records, as the effect of the blast of the powder and of the air dragged along with it is so very great. The Ballistic Pendulum is still useful for determining the velocity of small-arm bullets, but for artillery purposes the electric chronograph has completely supplanted it.

Chapter IV. discusses Motion in Two Dimensions, and is perhaps the most generally important and interesting chapter in the book. A complete dynamical terminology is still a desideratum, and many new words must be coined; for, as De Morgan remarks, "We cannot wait for words, because Cicero did not know the Differential Calculus (or Dynamics)." At the same time it is a pity that the old word *Vis Viva*, meaning $Mv^2$, was not allowed to drop, to be replaced by *Kinetic Energy*, for $\frac{1}{2}Mv^2$. *Vis mortua* is forgotten as the name for *Work*, and *vis viva*, as the other manifestation of energy, should go too.

The dot notation of Fluxions has been introduced in places: this, though easy to write, is difficult to print, and is inconvenient sometimes with tall letters, while others, like $i$ and $j$, are already in their "dotage."

Dr. Routh would, in our opinion, make the working of the illustrative examples more clear, if he always followed the fundamental principle of taking moments about the centre of gravity, as if it was a fixed point: very few students can be trusted to apply the principle to moments about any other moving point, and the equations of relative motion on p. 178 are better kept out of sight of all but a select few.

Dr. Besant's treatment of questions on Initial Motion is in our opinion simpler of application and quite as rigorous as that given in § 199.

A very good collection of illustrative examples completes this chapter, but we miss the extension of the problem of the motion of a cylinder rolling down an incline to the case of a wheeled carriage or of a railway train, when the rotary inertia of the wheels is taken into account, including the determination of the proper position of the coupling chains and buffers; also the investigation of the stresses in the interior of a swinging body like a ship, not only in causing cargo to shift, but also in its physiological bearing on sea-sickness. An ordinary swing is useless as an antidote to sea-sickness, as the seat is close to the centre of oscillation. To feel the disturbing effect we must mount up above the axis of revolution; and to the deck and up the mast of a ship.

As interesting applications, we may mention the dynamics of billiards, §§ 179–98, and of the quintain in § 178.

After Chapter IV. the author launches off into dynamics in space, and now the difficulty of the subject is more than doubled.

Chapter VII., on Energy (or Vis Viva, as Dr. Routh still prefers to call it), precedes in importance and idea the Chapter VI., on Momentum, and might well change place. The idea of energy as $\frac{1}{2}Wv^2/g$ very soon received a name for its unit in the *foot-pound*, but the corresponding name for the momentum, $Wv/g$, of *second-pound* is as yet hardly known.

In this chapter the Principles of Dynamical Similitude are discussed. In Geometry the Principle of Similitude asserts that a theorem is true whatever the scale on which it is drawn; but in Dynamics the principle is much more complicated, and great care is required in arguing from the performance of a model or of a machine to one to be constructed to a larger scale. The subject is one of great importance at the present time in the discussion of the design of steamers intended to reduce the time of passage across the Atlantic to something under six days; and the statement of the laws to be applied as affecting steamers, first clearly laid down by Mr. Froude, might well find explanation and illustration at this point.

The impact of two rough elastic ellipsoids is treated in §§ 315, &c., by a mathematical *tour de force;* but the expression *perfectly rough* is never met with outside a Cambridge mathematical treatise. What would be the state of things, for instance, between two bodies in contact, one *perfectly rough* and the other *perfectly smooth?* When we wish to produce this so-called perfect roughness between two bodies, we cut teeth on them, to engage together; and in railway travelling the perfect smoothness of the road due to the employment of wheels must be capable of being turned into roughness by the application of the breaks: the continuous breaks now fitted to express trains have enabled a higher average speed to be maintained.

The General Equations of Motion of Lagrange and Hamilton, discussed in Chapter VIII., are not to be employed by any but very advanced students: the formation of these equations and the conversion of one form into the other constituting difficult and refined applications of the Change of the Variables.

In the case where some of the co-ordinates are absent, this part of the subject has received valuable development from Dr. Routh, by means of a principle now called the Ignoration of Co-ordinates.

The volume concludes with an investigation of the Small Oscillations of a System, important as a Stability Test; in such problems the author expresses the result very concisely by means of the length of the simple equivalent pendulum which synchronizes with the oscillations. An interesting problem to discuss is the theory of Mr. Yarrow's Vibrometer, employed for measuring the vertical vibrations of his torpedo-boats: a platform suspended by springs is found to preserve a constant level, if the free period of the vertical oscillations of the platform is incommensurable with the period of the vibrations of the boat.

It is difficult to know where to stop in writing of treatises such as these two of Dr. Routh, so full of detail and interest; and the two treatises together would provide nearly a year's work for an industrious student, who would thereby derive a thoroughly sound and complete knowledge of the subjects.

A. G. GREENHILL.

## *COLLECTIONS FROM THE ANDES.*

*Supplementary Appendix to Travels amongst the Great Andes of the Equator.* By Edward Whymper. (London: John Murray, 1891.)

THOUGH many travellers in new or little-known regions, who are not naturalists, have been in the habit of collecting to some extent the more remarkable

specimens which they have noticed, in various branches of the animal kingdom, yet, as a rule, both such collections and the reports upon them are more or less unsatisfactory to professed naturalists; partly because they usually represent mere fragments of the fauna of the regions explored, and partly because inexperienced collectors often pass over the most interesting species, and bring back common and wide-ranging forms of comparatively little interest.

Alpine climbers in particular, as a class, have done so little for zoology in Europe or the Caucasus, that we hardly expected that Mr. Whymper, whose reputation for daring, determination, and endurance, puts him among the most distinguished of Alpine climbers, would now turn his attention to zoology. He has, however, shown the best possible example to his *confrères* by his Great Andean expedition; and has proved that it is possible without in any way neglecting the special objects of his journey, to do most valuable zoological work; and as the higher regions of the Andes have been neglected by professional collectors, who depend more or less on their success for payment of expenses, the proportion of new Coleoptera brought home by him is very great. Owing, no doubt, to the late Mr. Bates's good advice, Mr. Whymper has secured the assistance of many specialists of eminence in describing his collections, and the work is profusely illustrated with wood-cuts of the highest class, better by far than many of the coloured illustrations which often appear in scientific periodicals.

The total number of species collected amounts, according to Mr. Bates, to about one thousand, but the Diptera, Lepidoptera-Heterocera, Hymenoptera (except the ants), and Arachnida have not been described, on account of the difficulty of finding anyone to work them up; and as the birds do not seem to have attracted much of Mr. Whymper's attention, and fishes are almost wanting in the higher mountain streams, the greater part of the book is taken up by descriptions of the Coleoptera by Messrs. Bates, Sharp, Gorham, Olliff, and others. Messrs. Godman and Salvin have written a chapter on the butterflies, but of these very few occur at elevations of 10,000 feet and upwards; and only two Satyridæ, two species of Lycæna, two Pieris, and two Colias, were taken at or above 12,000 feet. This is a strong proof of the poverty of the high Andes in endemic forms, as compared with the high Alps of Europe and Asia, where, notwithstanding the severity of the climate, a large number of species are found at elevations which, when allowance has been made for the latitude, are much higher than these. This may be accounted for to some extent by the weather, which appears to be, in the high Andes of Ecuador, very wet and windy during the whole year. It is farther explained by the late Mr. Bates in the following remarks, taken from the introduction which he has contributed to the volume:—

"It seems to me a fair deduction from the facts here set forth that no distinct traces of a migration during the lifetime of existing species, from north to south or *vice versâ*, along the Andes have as yet been discovered, or are now likely to be discovered. It does not follow, however, that the Darwinian explanation of the peculiar distribution of species and genera on mountains in the tropical and temperate zones, and in high latitudes of the Old World, is an erroneous one. The different state of things in the New World is probably due to the existence of some obstacle to free migration, as far as regards insects, between north and south, both during and since the Glacial epoch. The problem, like most others relating to geographical distribution, is a complicated one; but there are one or two considerations, likely to be overlooked, which may tend to its solution. One is the great altitude at which the vigorous denizens of the teeming tropical lowlands flourish on the slopes of the Andes. Mr. Whymper found, for example, species of many of the genera of Longicorn Coleoptera characteristic of the lowland forests at altitudes of 9000 and 10,000 feet, and Kirsch has recorded numerous species of *Lampyridæ*, *Lycidæ*, and other families belonging equally to tropical American forest genera, as met with by Reiss and Stübel in Colombia and Ecuador at 12,000 feet. In Ecuador all the warm moisture brought by the eastern trade-winds is not intercepted even now by the wall of the Andes, and wherever that falls, in the depressions, conditions of climate and vegetation will be created suitable to these encroaching tropical forms. If we add to this the barrenness and generally unfavourable conditions of the zone above those altitudes, there can be little wonder that temperate forms have not freely passed along the Andes. Another consideration is that there may have been a breach of continuity of the land in Glacial times, at the Isthmus of Panama, sufficient to prevent free migration. It may, further, be legitimate to speculate on the possibility of the Andes being lower in the tropical zone during the Glacial epoch. A few hundred feet lower than the present altitude, combined with the copious warm rains which must have accompanied the age of ice, would present conditions undoubtedly favourable to the spread of tropical forms over the whole area which would successfully resist the invasion of high northern or southern species. The main principle in distribution, however, is that forms sooner or later, and in proportion to their intrinsic and extrinsic facilities of dissemination, will find their way all over the world to wherever the conditions inorganic and organic are favourable to their acquiring a footing. That these facilities are possessed in a higher degree by plants than insects and some other groups of animals may be a sufficient explanation of the fact that so many species of plants have surmounted the obstacles to their passage from north to south during the last Glacial epoch, while few or no insects have done so. The more distant, or generic, relationship between the insects of Chili and those of the north temperate zone can only be explained on the assumption of a migration at some epoch far more remote than the last Glacial epoch."

Mr. Whymper's book as a whole is a remarkable example of his talent as an explorer, a mountain climber, and an accurate observer both of physical, geographical, and natural history phenomena, and though we have waited eleven years for its appearance, nothing has been lost and much has been gained by this delay, and his book will take rank among the very best works of scientific travel which have ever been written.

H. J. ELWES.

## THE HISTORY OF EPIDEMICS.

*A History of Epidemics in Great Britain from* A.D. 664 *to the Extinction of Plague.* By Charles Creighton, M.A., M.D. (Cambridge: University Press, 1891.)

THE task undertaken by Dr. Charles Creighton in writing a history of epidemics in Britain from 664 (the year of the first pestilence recorded by an authority that can be regarded as contemporary) to the

extinction of plague is one of enormous difficulty. The materials for such a history must be sought for high and low; chance allusions in private letters or municipal records will supply links in the chain of evidence for which the writings of the medical authorities of the time may be searched in vain, if indeed there be any medical authorities; and Dr. Creighton found that for his purposes "medical books proper are hardly available . . . until the end of the Elizabethan period, . . . and do not begin to be really important . . . until shortly before the date at which" his present labours end. When such evidence as can be found has been found and sifted, there still remains the most intricate problem of all—that of tracing the epidemics recorded to their origin, accounting for their spread, and in some cases explaining why a country should in modern times be spared diseases which scourged it in the Middle Ages.

No better illustration of these difficulties could be found than is supplied by chapter ii., "Leprosy in Mediæval Britain." The first point that Dr. Creighton has to make clear is that all the so-called lepers were not really lepers. In extreme cases the word "leprosus" may have been used simply as meaning "beggar or common tramp"; elsewhere it may have been applied to victims of syphilis, lupus, and so forth. For the sufferers special provision was no doubt made, on a scale due in part to a morbid or mistaken religious sentiment; but examination of the charters and other documents relating to these charities suggests that, of the supposed foundations for lepers, some were merely refuges for sick and infirm poor, in others provision was made for three or four times as many non-leprous as leprous inmates, while from others, towards the end of the thirteenth century, the lepers were disappearing or getting displaced. Finally, the author concludes that the prevalence of true leprosy at any time in England was probably not so great as in the worst provinces of India at the present day; but, however justifiable scepticism as to its supposed ravages may be, that the disease really did prevail can hardly be doubted, and the reasons for doubt are lessened, if a *vera causa* for its presence can be found. Such a *vera causa*, compatible with its subsequent disappearance, may be discovered, not in "importation," *e.g.* by Crusaders—a suggestion Dr. Creighton does not consider worth thinking about—but in the staple diet of the times, a semi-putrid or toxic character of animal food combining with other depressing influences to give rise to leprosy, just as a similar character of bread or porridge gives rise to pellagra.

We have given the arguments of this chapter somewhat in detail, because the criticism which obviously applies to them, applies elsewhere. Considering the uncertainty which surrounds the facts, it is clear that the traditions of the leprosy of the past cannot very materially assist, though they may be explained by, the study of modern leprosy. Similarly, in the case of the plague, to which naturally Dr. Creighton devotes much of his book, to say nothing of that old question, the value of the evidence of the Bills of Mortality, the inquirer is met at once by the great difficulty of knowing when "the plague" which is spoken of as invading out-of-the-way places really was the genuine plague—a point of vital importance, as soon as any etiological questions are raised, and we may here observe that Dr. Creighton writes:—

"In concluding the career of the sweat in England, we may pass from it with the remark that it did not cease until other forms of pestilential fever were ready to take its place. The same explanation remains to be given of the total disappearance of the plague from England after 1666: it was superseded by pestilential contagious fever, a disease which was its congener, and had been establishing itself more and more steadily from year to year as the conditions of living in the towns were passing more and more from the mediæval type to the modern."

It would be impossible here to enter into the merits or the reverse of all Dr. Creighton's explanations of the facts he records. In the chapter on small-pox, which is likely to be the one first consulted, we find a passage which disarms criticism: "It has been the fate of small-pox as an epidemiological subject to be invested with bigotry and intolerance." Yellow fever has as yet hardly sunk to that deplorable level; and as Dr. Creighton's theory appears to be that "the dysenteric matters of the negroes" carried on the slave ships "had themselves in turn bred an infection of yellow fever for the whites," it may be asked whether the alleged protection of Africans of pure blood from the infection of yellow fever "in all circumstances ashore or afloat, . . . not by acclimatization but by some strange privilege of their race," is either supported by all recent authorities, or not capable of the explanation that in infancy they may pass through some disease too slight to be recognized as yellow fever, but which serves to confer immunity.

The general impression left upon the mind by this history is that it would have been a wise policy to make two books instead of one out of the materials collected—in one simply to bring together such facts as Dr. Creighton's industry has gleaned from the authorities, and in the other to enter upon the questions of etiology, which are bound to give rise to interminable discussion.

Besides those we have mentioned, gaol fevers, influenzas, "the French pox," and scurvy in early voyages, are the principal diseases treated of in this volume. In dealing with influenza Dr. Creighton draws attention to the relation in point of time between the outbreaks in the latter half of the sixteenth century and great epidemics of plague, and a somewhat similar relation between fever and influenza and exceptional climatic conditions in the years 1657-59.

## OUR BOOK SHELF.

*Mineralogy*. By Frederick H. Hatch, Ph.D., F.G.S., of the Geological Survey of England and Wales. (London: Whittaker and Co., 1892.)

DR. HATCH has followed up the publication of his excellent "Introduction to the Study of Petrology," recently noticed in these pages, by a little book on mineralogy, which will, we think, be of equal service to students. He has recognized the fact that for one person who desires to enter upon a systematic study of mineralogy, regarded as a natural-history science, there are twenty who need only such an amount of mineralogical information as will enable them to profitably commence the study of geology. We think, therefore, that the prominent place given to the felspars, the pyroxenes, the amphiboles, the micas, and similar common rock-forming species in this work, is fully justified; and not less so the unsystematic but convenient grouping of other minerals as "ores and veinstones," "salts and other useful minerals," and "gems or precious stones." De Lap-

parent has indeed shown how a classification of minerals according to their mode of occurrence may be employed even in a systematic treatise; but Dr. Hatch's more humble attempt is not open to the criticism to which an ambitious work on the same lines would obviously be liable. It is clear that in a book of this kind there is not much scope for originality of treatment, but Dr. Hatch has admirably united brevity and clearness in his treatment of the crystallographical and physical characters of minerals. His method of giving the names and commonly employed reference letters to the crystal-combinations which he figures is well adapted to prepare the student for consulting larger treatises on the subject. So, too, the reference to the use of symbols, though it must evidently be very slight in a work of the dimensions of that before us, is eminently judicious. A short table of symbols of the chief forms belonging to each system, according to Miller and Naumann, will enable the beginner to recognize the meaning of all the very commonly occurring combinations; and it is clearly inexpedient to attempt more than this in such a very elementary work. We can confidently recommend the book as an excellent summary of mineralogical science, adapted to the wants of the geological student; and we believe the perusal of this small work may even be of advantage to those who desire to enter upon the more systematic study of the science of mineralogy. J. W. J.

*To the Snows of Tibet through China.* By A. E. Pratt, F.R.G.S. (London: Longmans, Green, and Co., 1892.)

THE author of this book says in the preface that he has done his best "to withstand the temptation to generalize from limited experience, to which travellers in China seem peculiarly liable." Yet in his last sentence he expresses the opinion that several incidents he has mentioned "will show what a credulous and cowardly race the Chinese are." It ought surely to have occurred to him, when he set down this harsh and rather foolish judgment, that it was a striking example of the kind of generalization which he had wished to avoid. Fortunately the statement, although it seems to convey Mr. Pratt's final impression of the Chinese people, does not represent the general character of his work, in which scientific readers will find a good deal to interest them. He went to China in 1887 for the purpose of studying the natural history of the country, and remained until 1890, fixing his head-quarters at Ichang, a town on the left bank of the Yang-tze-Kiang, 1110 miles from its mouth. He crossed the frontier of Tibet, and at Tatsien-lu met Mr. Rockhill, whose excellent account of travels in Tibet we lately reviewed. Mr. Pratt worked hard in the various regions he visited, and collected many valuable specimens in several departments of natural history. He has not a very bright or attractive style, but many of his facts are themselves so interesting, and his enthusiasm as a collector is so keen and persistent, that there are few passages which his readers will desire to skip. In an appendix, Dr. Albert Günther gives a list of the species of reptiles and fishes brought by Mr. Pratt from the Upper Yang-tze-Kiang and the province Sze-chuen, with a description of the new species. There are also lists of birds and of Lepidoptera.

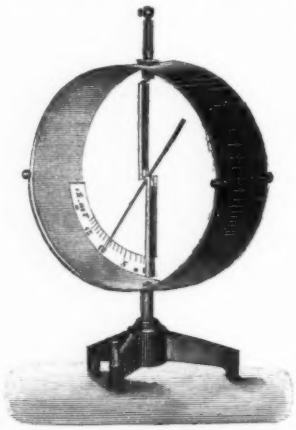
## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Absolute Electrometer for Lecture Purposes.

I THOUGHT it might be welcome to some of your readers to be made acquainted with the following simple and cheap instruments which I have now used for some years with advantage in lectures, and also for many scientific purposes. They are electrometers, which are divided directly into volts. The needle, which is made of aluminium, moves about a horizontal axis of hard steel, and is repelled from the vertical brass piece connected with the knob above. The instruments have the advantage that they are much easier of manipulation than the gold-leaf electroscope, while the sensibility is nearly the same, and fully suffices for all lecture purposes. Potentials are read off directly in volts, so that the measurements in the experiments on electrostatics and electrodynamics can all be referred to the same unit, whereby the conception of the student gains in distinctness, and the lecture in simplicity. In consequence of the specially careful workmanship, the needle adjusts itself quickly and with certainty, so that readings may be made to about 10 volts. The back and front consist of glass disks 1 mm. thick, each of which covers a plate of zinc of the same size, out of which are cut two equal and opposite slits, through which the position of the needle on the brass scale is read off. The readings of the instrument are only correct when these plates are in position.

When the instrument is used in the lecture, the two plates are taken away, and the back glass plate covered with tissue paper,



the instrument being illuminated from behind. The deflections are then easily visible in a room for more than a hundred students.

The method of graduation of these instruments I have described in full in *Wiedemann's Annalen*, vol. xliv., 1891, p. 771. They can be procured from the University mechanician here, Herr Albrecht, in three different sizes, 0–1500, 0–4000, and 0–10,000 volts. The first of these is the substitute for a gold-leaf electroscope. Herr Albrecht also makes the instruments for technical purposes. F. BRAUN.

Physical Laboratory, Tübingen, May 28.

### Saturn's Rings.

THE writer of the "Astronomical Column," in your number of June 2, directs attention to some observations of M. Bigourdan on certain peculiarities in the appearance of the following arm of Saturn's Rings observed by him on May 21. He mentions in particular a protuberance situated near Cassini's division. This, I think, is easily accounted for in a quite different manner. At 9h. 6m. p.m., according to Marth's ephemeris, two satellites, Enceladus and Tethys, were in conjunction with the east end of the ring. They were going in apparently opposite directions, Tethys away from Saturn. Their conjunctions with the middle of the Cassini division would, I find, take place at 8h. 36m. p.m. for Tethys, and at 9h. 36m. p.m. for Enceladus. Both satellites would be so close to the ring as to appear inseparable from it. Tethys, moving in an orbit inclined as much as 65′ to the plane of the rings, might easily be half superposed in appearance upon the *northern* boundary of the rings. The following remarks are from my observation-book of date May 21:—

"9h. 13·5m. G.M.T. The broadening of the east ansa near its end is probably due to Tethys and Enceladus being on opposite sides of it near its east end. 9h. 22m. The east ansa seemed a little longer than the west, perhaps due to Tethys now following it. Dione was seen close to the east end."

With the other observations and remarks of M. Bigourdan I quite agree. The straightening of the northern edge of both ansæ has frequently been noticed by me both before and after May 20. So lately as June 3 both ansæ seemed broadest at a distance of three-fifths of their length from the ball, and the following ansa was almost detached from the ball, partly by the shadow thrown by the ball on it, and partly by the more elevated part of the middle ring concealing all within it in the neighbourhood of the ball. A. FREEMAN.

Murston Rectory, Sittingbourne, June 6.

### Aurora.

THE aurora of May 18 was seen here. I first noticed it at 11 p.m. (Dublin time), and watched it until 1 a.m., though I did not see either the beginning or the ending. It extended from west-north-west to north-north-east, and had a general altitude of 30°, though occasional streamers reached beyond Polaris. It was moderately bright, but certainly not brilliant, and showed no colour. About 12 o'clock horizontal streamers began to show themselves like electric search-lights, and continued for some time, their appearance being accompanied by a lengthening upwards of the radial streamers. The air was slightly hazy, and there was much stratus about, with detached masses of cumulo-stratus coming up from the west. Wind-force 3 of Beaufort's scale; barometer 30·05, stationary.

JAMES PORTER.

Crawford Observatory, Queen's College, Cork, May 31.

### The Atomic Weight of Oxygen.

I NOTICE that Lord Rayleigh gives the following summary of results on the atomic weight of oxygen :—

| | | |
|---|---|---|
| Dumas | 1842 | 15·96 |
| Regnault | 1845 | 15·96 |
| Rayleigh | 1889 | 15·89 |
| ,, | 1892 | 15·882 |

showing the remarkable fact that the atomic weight has been steadily decreasing for the last fifty years. I would suggest, as the explanation of this, that the increased population of the world, together with the great consumption of coal, have caused great wear and tear of these atoms, so that they are now mostly deficient in weight. It would seem, in fact, desirable that a Congress of chemists should be called to consider the question of providing for the renovation of the oxygen supply, and issuing trustworthy atoms of the standard weight, 16, as sealed patterns.

ROBT. LEHFELDT.

Firth College, Sheffield, June 3.

### The Nitric Organisms.

I AM most reluctant to occupy any of your space with a claim to priority. A statement made on p. 137 of your last issue can hardly, however, be allowed to pass without notice. Dr. P. F. Frankland states in his lecture at the Royal Institution that the possibility of the existence of a nitric organism was foreshadowed by himself, and that this hypothesis has recently been confirmed by Winogradsky. He then describes the method adopted by Winogradsky for separating the nitric from the nitrous organism, and the chemical properties of the former. The fact that the existence of a nitric organism was proved in the first instance by myself, its separation from the nitrous organism effected, and its chemical behaviour studied, before any publication on the subject by Winogradsky, is *entirely omitted!* Frankland's statement of the case is the more remarkable as Winogradsky frankly admits in his paper that our results were nearly the same, and that his were published subsequently to my own.

R. WARINGTON.

Harpenden, June 10.

### Carnivorous Caterpillars.

EVERY experienced breeder of Lepidoptera knows to his, or her, cost that many caterpillars are either habitually, or casually, carnivorous and cannibalistic.

Useful hints on this subject are given in Dr. Knaggs' "Lepidopterist's Guide" (Gurney and Jackson).

Lewisham, June 13. R. MCLACHLAN.

### The Cuckoo in the East.

IN May 1887 I wrote to you that I had heard the cuckoo at Mussoorie. This year, on coming up here, I heard it at Doneira (about 2000 feet) and at Mamul (4000 feet). I have been here five days and have not heard it at all. There has been a deficiency of rain here, and it has been unusually hot. Both notes were very clear and distinct.

Dalhousie, May 22. F. C. CONSTABLE.

## *THE NEW LONDON UNIVERSITY.*

WE have received for publication from the Association for Promoting a Professorial University for London the following proposals, adopted by the Association at a meeting held on Tuesday last :—

(1) It is desirable that there should, if possible, be one University in London.

(2) The objects of the University should be to organize and improve higher education and also to promote the advancement of science and learning.

It is desirable that the University be constituted on the following lines :—

(3) Subject to Clauses (9) and (12) the University to be governed by a Senate which shall ultimately consist of the Professors and a certain number of Crown nominees.

(4) The Professors to be nominated in the first instance by some independent authority, such as the Crown or the Commission contemplated in Clause (14), afterwards in such manner as the Senate may determine.

(5) The University to have power to absorb institutions of academic rank in London, which may be willing to be absorbed, due provision being made for protecting the interests of the teachers in such institutions, and for preserving the character of special trust-funds.

(6) The University to have the power of appointing Readers and Lecturers, either to supplement the teaching of the Professors, or to deliver graduation or other courses of lectures within the metropolitan area at such places as may be determined by the Senate.[1]

(7) The University to have power to grant degrees and to institute degree examinations. These examinations may, if found necessary, be different for those who have followed prescribed courses and for those who have not. Each Professor of the University to be *ex officio* an Examiner in the subject of his chair, but not necessarily to take part in every examination in that subject. Examiners, who shall not be Professors in the University, to be appointed by the Senate to take part in all degree examinations.

(8) The Professors, Readers, Lecturers, and other Teachers of the University to be grouped into Faculties, which shall have such consultative and administrative powers as shall be determined by the Senate.

[1] This side of the University work would probably include teaching of the following kinds :—

(*a*) Teaching, conducted in the University Buildings, supplementary to that of the Professors.

(*b*) Courses of instruction of a special or advanced character recognized by the University, *e.g.* of the type given by the German *Privat-Docenten*.

(*c*) Teaching of a more or less academic character conducted by lecturers appointed by the University at Institutions and Colleges, the objects or the standing of which render complete absorption into the University undesirable.

(*d*) Lectures at various local centres of the type known as "University Extension" lectures.

(*e*) Courses of lectures or occasional lectures by members of the University staff, or by other persons recognized by the University, for which a convenient centre might, with the co-operation of the Corporation of London and of the Mercers' Company, be found at Gresham College.

(9) The Body of Graduates in Convocation assembled to have the power of appealing to the Privy Council, but to have no veto upon the action of the Senate. The Chairman of Convocation to be *ex officio* a member of the Senate.

The Medical Schools will probably require special treatment. Though they might advantageously hand over the teaching of pure science to the University, each school might retain control over its own teaching of medicine and surgery and over the funds devoted thereto.

(10) The Medical Faculty to consist of representatives elected by the Teachers in recognized London Medical Schools.

(11) The recognized Medical Schools to be determined in the first instance by the Commission referred to in Clause (14), but afterwards from time to time by the Senate, subject to appeal to the Privy Council.

(12) A certain number of the members of the Medical Faculty to be nominated University Professors in accordance with the provisions of Clause (4). The number of Medical Professors on the Senate not to exceed one-fourth of the total number of University Professors on the Senate.

(13) A teacher of pure science in a recognized Medical School to become a Member of the Faculty of Science, whenever the appointment to his post is entrusted permanently or *pro hac vice* to the Senate of the University.

(14) To facilitate in the first instance the organization of the University, it is suggested that a small and independent Commission of legal and educational authorities be appointed by Act of Parliament with full powers—

(*a*) To investigate and determine upon the claims of institutions wishing to be absorbed under Clause 5.

(*b*) To arrange for the proper disposal of the trust-funds of those institutions which may be absorbed, and to determine the conditions under which their property shall be vested in the Governing Body of the University.

(*c*) To arbitrate on all matters concerning the interests of existing teachers as affected by the action of Clause (5), and

(*d*) Generally to make such arrangements as may be necessary for the establishment of the University on the foregoing lines.

We are requested to add that the names of those desirous of supporting the Association will be received by any member of the Executive Committee,[1] or may be sent directly to the Secretary (Prof. Karl Pearson, Christchurch Cottage, Hampstead, N.W.). The Association already numbers some seventy members, including Profs. H. E. Armstrong, F.R.S., W. E. Ayrton, F.R.S., F. O. Bower, F.R.S., O. Henrici, F.R.S., E. Frankland, F.R.S., E. Ray Lankester, F.R.S., F. Max Müller, O. J. Lodge, F.R.S., Norman Lockyer, F.R.S., W. J. Russell, F.R.S., W. A. Tilden, F.R.S., H. Marshall Ward, F.R.S., Principals H. R. Reichel, W. M. Hicks, F.R.S., and C. Lloyd Morgan, besides many other names equally well known in literature, science, and art. A complete list will shortly be issued.

## *SUBDIVISIONS IN ARCHÆAN HISTORY.*[2]

### 1. *Subdivisions based on Kinds of Rocks.*

WERNER'S idea that kinds of rocks and grade of crystallization afford a basis for the chronological subdivision of crystalline rocks is more or less apparent in nearly all attempts that have since been made to lay down the general subdivisions of Archæan terranes. The "fundamental gneiss" has gone to the bottom and the thinner schists to the top. There is a degree of truth in the idea. But the assumptions are so great that at the present time little reason exists for the earnestness sometimes shown by advocates of such systems. The idea has little to sustain it in the known facts of geology. The following are sufficient to decide the question.

According to the thorough petrological and geological study of the rocks of the Bernardston region by Prof. B. K. Emerson [1]—a region in the Connecticut valley, in the towns chiefly of Bernardston, Massachusetts, and Vernon, Vermont—there are the following rocks: granite, largely feldspathic; dioryte, so like intrusive dioryte that it had been pronounced trap; quartz-dioryte; granitoid gneiss faintly foliated with biotite and passing into the granite; hornblende schist; quartzyte; quartzyte prophyritic with feldspar crystals; staurolitic and garnetiferous mica schist; hydromica schist; argillyte; massive magnetite, making a bed of magnetite rock; along with coarsely crystalline limestone and quartzytic limestone containing Crinoids, Corals, and Brachiopods: all together making one series of rocks of later Devonian age. My own observations in the region confirm the conclusions of Prof. Emerson. Such facts prove, moreover, that "massive" as applied to crystalline rocks does not signify *igneous*. The granite is not eruptive granite, but part of a stratum which is elsewhere quartzyte, the quartzyte graduating into granite; the latter was never in fusion.

Again: on the borders of New England and New York there are schists of all gradations from massive Cambrian gneiss to Cambrian and Hudson River hydromica schist and argillyte, the age fixed by fossils. Becker reports similar facts from the Cretaceous of California. Such observations, and others on record, make it hazardous to pronounce any gneiss in an Archæan area "fundamental gneiss," or any associated slaty schist the younger of the two. It may be true; but it may not be. It is probable that the thin-bedded schists are absent from the older Archæan, but not that the thick-bedded and massive are absent from the later Archæan.

The little chronological value of kinds of crystalline rocks in the later Archæan comes out to view still more strongly if we consider with some detail the length and conditions of Archæan time.

The earth must have counted many millions of years from the first existence of a solid exterior, when the temperature was above 2500° F., to the time, when, at a temperature below 1000° F.—probably near 500° F., supposing the atmospheric pressure to have then been that of 50 atmospheres—the condensation of the waters of the dense aërial envelope had made such progress that an ocean, moving in tides and currents, had taken its place on the surface.[2] There were other millions afterward along the decline in temperature to the 180° F. mark—180° F. the mean temperature of the ocean—when, according to observations on living species, the existence of plants in the waters became, as regards temperature, a possibility;[3] and still other millions from the 180° F. mark to that of 120° F., or nearly, when marine animal life may possibly have begun its existence. And since cooling went on at a decreasing rate toward the end, time was also long from the 120° F. mark to that of a mean oceanic temperature of 90° F., or below it, when Paleozoic life found congenial conditions in the water. The mean temperature now is about 60° F.

[1] This Committee at present consists of the following:—F. V. Dickins, G. Carey Foster, R. S. Heath, E. Ray Lankester, Karl Pearson, H. E. Roscoe, A. W. Rücker, T. E. Thorpe, W. C. Unwin, W. F. R. Weldon.

[2] Reprinted from the June number of the *American Journal of Science*, rom advance sheets forwarded by the author. The paper is to be continued in the *American Journal of Science*.

[1] A description of the "Bernardston Series" of Metamorphic Upper Devonian Rocks, by Ben K. Emerson, *American Journal of Science*, III., xl., 263, 1890.

[2] R. Mallet estimated, in view of the density of the atmosphere—over 200 atmospheres to the square inch—that the first drops of water may have been condensed on the earth's surface when the temperature was that of molten iron.—*Phil. Mag.*, January 1880.

[3] They live now in waters having a temperature of 200° F., Brewer, at Pluton Creek, California; 185°, W. H. Weed, Yellowstone Park. Moreover germs of Bacilli have germinated after having been boiled for an hour.

The ocean, sooner or later after its inaugural, began the work of making permanent sediments, that is sediments that were not speedily recrystallized; and these sediments, through the millions of years that followed, must have been of all kinds and of great thickness.

The conditions became still more like the present after the introduction of life with the further decline of temperature. Even before its introduction, iron oxides, iron carbonate, calcium carbonate, calcium-magnesium carbonate, and calcium phosphate had probably commenced to form, for the atmosphere, although it had lost the larger portion of its water-vapour, still contained, as writers on the "primæval earth" have stated, the chief part of its carbonic acid, amounting to all that could be made from the carbon of the limestones, coal and carbonaceous products now in the world. It had also a great excess of oxygen—all that has since been shut up in the rocks by oxidations. And these most effectual of rock-destroying agents worked under a warm and dripping climate.

The amount of carbonic acid, according to published estimates, has been made equivalent in pressure to 200 atmospheres, or 3000 pounds to the square inch. 200 is probably too high, but 50 atmospheres, which is also large, is perhaps no exaggeration. Hence, the destruction of rocks by chemical methods must have been, as Dr. Hunt and other writers have urged, a great feature of the time; and long before the introduction of living species, the temperature had so far declined that the making of silicates must have given way in part to the making of deposits of carbonates and oxides.

But with the existence of life in the warm waters, through the still later millions of years, there should have been, as Weed's study of the Yellowstone Park has rendered probable, abundant calcareous secretions from the earliest plants, and, additions later, through the earliest of animal life. Great limestone formations should have resulted, and large deposits of iron carbonate, and perhaps iron oxides, over the bottom-sediments of shallow inland or sea-border flats, besides carbonaceous shales that would afford graphite by metamorphism.

In fact, long before the Archæan closed, the conditions as to rock-making were much like those that followed in the Paleozoic. Surely, then, all attempts to mark off the passing time by successions in *kinds* of rocks must be futile. Some *varieties* of the various kinds of rocks are probably Archæan only; but not all those of its later millions of years. Even crystalline and uncrystalline may not be a criterion of chronological value. The beds of the Upper Archæan, under the conditions existing, may well, over some regions, be uncrystalline still, and may include carbonaceous shales that hold to this time their carbonaceous products. Such uncrystalline beds may now exist over the Continental Interior; for the great Interior has generally escaped when metamorphic work was in progress on the Continental borders.

The amount of carbonic acid is most readily estimated by first obtaining the probable amount for all post-Archæan sources, and then adding to this that which is indicated by Archæan terranes. The calculation is here given in detail that others may use it for deductions from other estimates.

For the estimation there are the following data. A cubic foot of pure limestone which is half calcite and half dolomite and has the normal specific gravity 2·75, weighs 171·4 pounds; and this, allowing for $\frac{1}{12}$th impurity, becomes 157 pounds and corresponds to 72 pounds of carbonic acid. A cubic foot is equal to an inch-square column 144 feet in height. Since 72 is half of 144, each foot of the column of such limestone contains half a pound of carbonic acid. Hence a layer of the limestone one foot thick would give to the atmosphere, on decomposition, half a pound of carbonic acid for each square inch of surface.

A foot layer of good bituminous coal containing 80 per cent. of carbon, G=1·5, will give to the atmosphere by oxidation 1·9 pounds of carbonic acid per square inch of surface.

If the mean thickness of the limestone over the whole earth's surface, that of the oceans included, reckoned on a basis of $\frac{1}{12}$th impurity, is 1000 feet, the contained carbonic acid amounts according to the above to 500 pounds per square inch, or 34 atmospheres (of $14\frac{3}{4}$ pounds), and if the mean thickness of the coal is one foot, the carbonic acid it could contribute would be 1·9 pounds per square inch. Adding these amounts to the carbonic acid corresponding to the carbon in the mineral oil and gas and other carbonaceous products of the rocks and organic life, supposing it to be six times that of the coal, the total is 513·5 pounds, or 35 atmospheres. The mean thickness of Archæan calcium, magnesium, and iron carbonates is not a fourth of that of post-Archæan. Estimating the carbonic acid they contain and that corresponding to the graphite of the rocks at ten atmospheres, the whole amount becomes 45 atmospheres.

To bring the amount up to the estimate for early Archæan time of 200 atmospheres of carbonic acid, the mean thickness of the limestone for Archæan and post-Archæan time should be taken at nearly 6000 feet.

Part of the limestone of post-Archæan terranes was derived from the wear and solution of Archæan limestones, iron carbonate, &c., and hence all the 35 atmospheres to the square inch were not in the atmosphere at the commencement of the Paleozoic. But if we reduce the 35 atmospheres, on this account, to 25 atmospheres, it is still an enormous amount beyond what ordinary life, even aquatic life, will endure. Reducing the estimated mean thickness for the limestone layer over the globe from 1000 to 500 feet would make the amount nearly one half less.[1]

The making of carbonates early began the work of storing carbonic acid and purifying the atmosphere; and the introduction of life increased the amount thus stored, and added to it through the carbonaceous materials from living tissues contributed to the earthy deposits. But with all the reductions that can be explained, the excess is still very large. It has been proved by experiment that an excess also of oxygen diminishes the deleterious influence of carbonic acid on plants; and that if the amount of this gas is made equal to that of the oxygen in the present atmosphere, plants will still thrive. How far this principle worked in early time cannot be known.

### 2. *Subdivisions based on Stratification.*

The stratification in an Archæan region affords the only safe and right basis for subdivisions. This method has been used in the separation of the Huronian from the older Archæan; and recently, with good success, by Irving and Van Hise in the study of the Penokee-Marquette region, or the Huronian belt of Wisconsin and Michigan. The intimate relation of the beds in the series has been worked out and their unconformability with the lower rocks thus ascertained, besides the stratification and constitution of the iron-ore series within the belt. This is the first step toward that complete study which should be carried on throughout all Archæan areas, however "complex." The distribution of the rocks and their apparent or real stratigraphic succession, whether massive or schistose, the positions of the planes of foliation or bedding, the unconformities in superposition, and those of mere faulting, and all structural conditions, should be thoroughly investigated. Correlation by likeness of rocks has its value within limited areas, but only after

[1] A right estimate is very desirable. If made for North America, it could not be far out of the way to assume it to be a mean for like areas of the other continents as regards the limestone. But with the best possible result for the continents, the oceanic area, three times that of the continents, and out of the reach of investigation as to depths of bottom deposits, remains a large source of doubt.

much questioning.[1] The work is easy in its methods, yet perplexing because in North America the uplifts and flexures of different periods have in general taken place in parallel directions, so that unconformabilities are disguised, especially when the two formations are nearly alike in grade of metamorphism. Follow along the overlying to places where its metamorphism is of low grade, and there may be success.

There is a first point of special importance to be accomplished by Archæan investigation. The Huronian of the Penokee-Marquette region is partially metamorphic. To the east, the iron ore, according to the describers, is mainly metamorphic magnetite and hematite; to the west, especially in the Penokee region, it is largely iron carbonate, or the ore in its original state. Other facts show a diminishing grade of metamorphism to the westward. In the Penokee district, the ore is underlain by a bed of "cherty limestone," the chert of which, like the interlaminated jasper of the iron ore bed, is regarded by Van Hise as probably of organic origin, like later chert. It has among the overlying beds carbonaceous shales containing, according to Chamberlin, 40 per cent. of carbon, bearing thus evidence of very large organic carbonaceous contributions when in process of formation. The great beds of iron ore, the upward gradation eastward in metamorphism, the relations in position to the admitted Archæan adjoining it on the south, seem to prove the Huronian series to be Upper Archæan, as it has been generally regarded, but in a non-metamorphic and partially metamorphic condition. The question thence arises: Are the ore-bearing rocks of the Archæan of Eastern Canada, New York, New Jersey, and other parts of the Appalachian chain, Huronian in a state of *high-grade* metamorphism? Are the chondroditic limestones, which, in some localities, occur in and with the ore, part of the Huronian formation? Does the eastern iron-bearing series rest unconformably on inferior Archæan?

The *Algonkian* (or Agnotozoic) beds belong either to the Archæan or to the Paleozoic.

The Archæan division of geological time is of the same category with the Paleozoic, Mesozoic, and Cenozoic; all are grand divisions based on the progress of life, and they include together its complete range. There is no room for another grand division between Archæan and Paleozoic any more than for one between Paleozoic and Mesozoic. In contrast, the Algonkian division is not above the Cambrian in grade, it being based on series of rocks. Its true biological relations are in doubt, because fossils representing the supposed life of the period are unknown, or imperfectly so. The discovery in any rock so-called of Trilobites, Crustaceans, Mollusks, Brachiopods, or Crinoids, whatever the species, would entitle such rocks to a place in the Paleozoic, and either within the Cambrian group or below it. Walcott has already reported such fossils from the beds at the bottom of the Colorado cañon referred by him to the Algonkian—namely, besides a Stromatoporid, a small Patella-like or Discina-like shell, a fragment of a Trilobite and a small Hyolithes—forms which make the beds Paleozoic beyond question.

### 3. *Subdivisions based on Physical and Biological Conditions.*

Although the physical and biological conditions of the early globe are within the range of observation, there are generally admitted facts which afford a basis for a philosophical division of the time; and from it geology may derive instruction. The subdivisions to which we are led are the following:—

I. The ASTRAL æon, as it has been called, or that of liquidity.

II. The AZOIC æon, or that without life.

(1) The *Lithic era*, commencing with completed consolidation: the time when lateral pressure for crust-disturbance and mountain-making was initiated, and when metamorphic work began.

(2) The *Oceanic era*, commencing with the ocean in its place: oceanic waves and currents and embryo rivers beginning their work about emerged and emerging lands, and the tides, the retarding of the earth's rotation.

III. The ARCHÆOZOIC æon, or that of the first life.

(1) The *era of the first Plants*: the Algæ and later the aquatic Fungi (Bacteria); commencing possibly with the mean surface temperature of the ocean about 180° F.

(2) The *era of the first Animal life*: the Protozoans, and forms related to the embryos of higher invertebrate species; commencing possibly with the mean surface temperature of the waters about 120° F., and ending with 90° F. or below.

The subdivisions, as is evident, mark off great steps in the progress of the developing earth, although the rocks bear no marks of them that can be distinguished.

The Huronian period covered, probably, much of Archæozoic time; and this is all in the way of correlation that can be said. It is well to note here that if the Eozoon is really animal in origin, the "Laurentian" rocks of Canada in which it occurs must be Huronian, or the later of Archæan terranes.

Respecting the Oceanic period it is observed above, "*commencing with the ocean in its place.*" It appears to be almost a physical necessity that the oceanic depression should have been made in the first forming of the solid crust, if the globe cooled to the surface from the centre outward; that is, unless a liquid layer remained long afterward beneath the crust.

The depression was certainly made long before the close of Archæan time. For the enormous amount of rock-making of the Archæan over the continent implies the existence of emerged rocks with reach of the decomposing, eroding, and denuding agencies of the atmosphere and atmospheric and oceanic waters. A submergence in the ocean of 50 feet is almost a complete protection against mechanical and chemical wear. Moreover North America has its Archæan lands not only in the great nucleal mass, 2,000,000 square miles in area, but also in the series of Archæan ranges parallel to the outlines of the nucleus, which extend eastward to the eastern limit of Newfoundland, and westward to the Pacific. And it has correspondingly shallow-water Cambrian deposits lying between these ranges from Eastern Newfoundland and the coast-region of New Burnswick and Massachusetts, westward across the continent about most of the Archæan outcrops, to within 300 to 400 miles of the Pacific Ocean, as shown by Walcott.

There is hence reason for the conclusion that, at the close of Archæan time, the continent of North America was present not merely in outline, but also in general features, and at shallow depths where not emerged.

This fact with reference to North America means much. It means that by the end of Archæan time, the continents generally were essentially in a like condition—outlined

[1] As a preliminary in the study of any such region, thousands of dips and strikes of planes of foliation or bedding should be taken (in imitation of Percival's work before 1842, mentioned in the note on p. 440 of the last volume of the *American Journal of Science*), and all should be plotted on maps of large scale by means of symbols with affixed numbers recording the dips and strikes, for full comparison in the final elaboration. Even the Penokee-Marquette region needs further investigation with a clinometer-compass in hand

Before commencing the study of any crystalline rocks, models of flexures should have been studied until the fact is fully appreciated that a flexure having an inclined axis—the commonest kind—ranges through 180°, or nearly, in its dips and strikes, and until the characters of the bedding in different transverse sections of flexures are well apprehended. A good model for studying flexures may be made from a cylindrical stick of coarse-grained wood having the bark on (if of a smooth kind); it may be about four inches in diameter and twelve to fifteen long. Draw a straight line through the centre of one end; and from this line saw across obliquely to the edge at the opposite end. After planing smooth the sawed surface, the layers of the wood may then be coloured by groups; and three colours, or two besides that of the wood, are better than more. The model of a flexure having an inclined axis is then complete. Cross-sections of the model may be cut and the colours added to the new surfaces. For models of overthrust flexures, this method is not practicable, as wood of elliptical section would be required. They may be made of paper-pulp of three colours.

and at shallow depths where not emerged; that, therefore, the oceanic depression was then large and deep enough to hold the ocean. Further, this last fact indicates, if the mean level of the continents was coincident with the water's surface, that the oceanic depression had already a depth of 12,000 feet, or that of the present mean depth of the waters; and that the lowering, through later time, of the bed 1500 feet on an average (or 2000 feet according to other estimates) would give the continents their present mean height. And it is a fact of deep geogenic significance, that nearly 1000 feet of this mean height was received after the beginning of the Tertiary. JAMES D. DANA.

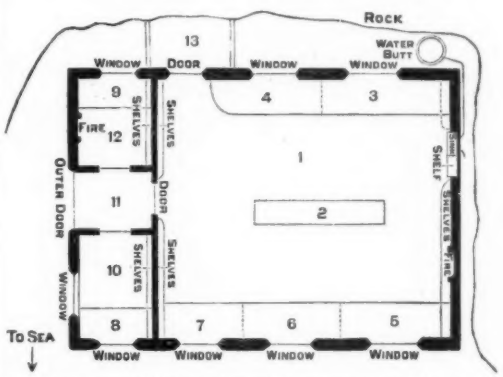
## *OPENING OF THE LIVERPOOL MARINE BIOLOGICAL STATION AT PORT ERIN.*

THE Liverpool Marine Biology Committee, which commenced the investigation of the fauna and flora of Liverpool Bay and the neighbouring seas seven years ago, and has kept up a small biological station on Puffin Island, Anglesey, for the last five years, passed on Saturday (June 4) into a new phase of its existence, and, it may be hoped, a more extended sphere of labour, when His Excellency Spencer Walpole, Lieutenant-Governor of the Isle of Man, declared the new marine laboratory at Port Erin to be open for work. The Puffin Island establishment has been very useful to the Committee, and well worth the small annual expenditure required for its modest outfit. It has been used by a few students who wished to gain a general knowledge of the common marine animals and plants in a living state, and by a limited number of specialists who went there to make observations, or who had the material for their investigations collected there and sent to them. But the Committee has felt for the last year, at least, that a station which was more readily accessible from Liverpool, and with hotel or lodging accommodation obtainable on the spot, would enable their members to do more work, and be of more use both to students and to investigators. Also, it was evident that after five years' work on the shores of the small island the greater number of the plants and animals had been collected and examined, and that a change to a new locality with a rich fauna and a more extended line of coast would yield increased material for faunistic work. On looking round the Liverpool Marine Biology Committee's district, Port Erin, at the southern end of the Isle of Man, at once presented itself as the best available place.

From its position, and the shape of the land, Port Erin has within a distance of a couple of miles in three directions—to Fleshwick Bay, to the Calf, and to Port St. Mary—a long and varied coast-line, with a number of small bays, furnishing good collecting-ground and shallow-water dredging. Two of these bays, Port Erin and Port St. Mary, have harbours with sailing-boats, and face in nearly opposite directions, so that in most winds one or other is sheltered and has a quiet sea. The rich fauna around the Calf and off Spanish Head is within easy reach: at a distance of three to four miles from the laboratory are depths of 20 to 30 fathoms, and at fourteen miles 60 to 70 fathoms. Although it is a considerable distance from Liverpool, still it is reached by a regular service of swift steamers and convenient trains, so that there is no uncertainty or delay in the journey.

The plan of Port Erin shows the position and surroundings of the Biological Station. It is on the beach at one corner of the bay, near where the sand and rocks join, and at the foot of the cliff upon which the Bellevue Hotel stands. It is connected with the road by means of a winding gravel path and steps, and is about a third of a mile from the railway station. It is just at the bottom of the hotel grounds, and arrangements have been made with the proprietor by which those working at the Biological Station can live comfortably and economically at the hotel. The sea comes to within a few yards of the windows, and the bay immediately in front is sheltered pure sea-water with a varied bottom, suitable for small boat dredging and tow-netting; while the rocky coast, extending out towards Bradda Head, has many creeks and good shore pools.

The station is a substantially built, three-roomed house, measuring a little over 30 feet by 20 feet, and standing on a solid stone and concrete platform, which raises it about 10 feet above high tide. It has windows looking out in three directions, north, south, and west. The front door leads into a passage, from which open to right and left two small rooms, which can be used as the Director's room and the Secretary's office, and will also be available for the use of members of the Committee, or any special students who require a separate room for their work. Opposite the entrance is the door into the main laboratory, which measures about 22 feet by 20 feet, and has windows on both sides. In front of the windows run strong fixed work-tables, which will accommodate five students with ease. At the ends of the room are fire-place, sink, tables, bookcase, and abundance




Plan of the Liverpool Marine Biological Laboratory at Port Erin. 1, Main laboratory (22 × 20), with work places for five students; 2, strong table for aquaria; 3 to 9, tables; 10, small laboratory for Director or members of Committee; 11, passage; 12, small laboratory or Secretary's office; 13, small yard.

of shelving, while along the centre runs a strong table for small aquaria and vessels containing animals. A door in one corner opens into a useful small yard between the house and the cliff, in which the concrete fresh water cistern is placed, and where dredges and other implements can be stored.

The Liverpool Salvage Association had kindly promised to lend their useful steamer, the *Hyæna*, to the Committee for four or five days at the time of opening; but as she was called off on duty at the last moment, they sent the steamer *Mallard* instead, on Friday afternoon, across to Port Erin, where she remained until Monday. Dredging trips in the neighbourhood took place on three of the days, and on Saturday evening tow-netting with submarine electric lights was carried on after dark in the bay.

At one o'clock on Saturday the Lieutenant-Governor, the Bishop, the Manx Attorney-General, and a number of members of the House of Keys, and others, arrived at Port Erin, where they were met by Prof. Herdman, Mr. I. C. Thompson, Mr. A. O. Walker, Mr. J. Vicars, Sir James Poole, and others of the L.M.B.C., along with some biologists from elsewhere. the Liverpool party numbering over thirty. The Governor was conveyed to the front of the Biological Station, where, after being presented by Prof. Herdman with the reports upon the

fauna of Liverpool Bay published by the L.M.B.C., he declared the building open for work, and then the party entered and proceeded to examine the results of the forenoon's dredging, laid out in dishes and under microscopes. At two o'clock the Governor and the Bishop were entertained to luncheon at the Bellevue Hotel by the L.M.B.C., Prof. Herdman being in the chair, with the Governor on the right and the Bishop on the left. Mr. I. C. Thompson, Hon. Sec. L.M.B.C., occupied the other end of the table, and about seventy in all sat down to luncheon, including the President and Secretary and some other members of the Isle of Man Natural History Society. The Governor proposed the toast of "The Liverpool Marine Biology Committee," to which Prof. Herdman replied.

The whole of the following day was spent in dredging and tow-netting from the *Mallard* to the west and south of Port Erin at the following localities:—

(1) 3 miles west of Fleshwick: 20 fathoms, 6 hauls of dredge: good varied ground, old shells, &c.

(2) 14 miles west of Dalby: 60 fathoms, 2 hauls; sticky clay mud, with few animals.

(3) 8 miles west of Fleshwick: 33 fathoms, 3 hauls.

(4) 6 miles west of Port Erin: 24 fathoms, 2 hauls.

(5) 1 mile west of Calf: 20 fathoms, 2 hauls.

(6) Off Kitterland, Calf Sound: 17 fathoms, 1 haul.

At each of these localities, besides the ordinary large dredge, tow-nets were used, and also Mr. Walker's small dredge with a canvas bag for bringing up samples of the bottom to be washed for small Crustacea, &c.

On the following day (June 6), on the way back to Liverpool, dredging from the *Mallard* was conducted at the following places:—

(1) 20 miles south-east from Port St. Mary: 26 fathoms.

(2) 25 miles south-east from Port St. Mary: 23 fathoms.

Both of these localities were good productive ground, and large hauls were obtained.

(3) 20 miles north-west from the Bar: 18 fathoms.

(4) 15 miles north-west from the Bar: 16 fathoms.

On all these occasions, besides the surface tow-nets, a bottom tow-net was attached a little way in front of the dredge, and appeared to work well; its contents were usually a good deal different from those of the surface nets.

Amongst the forms dredged in these two days were:—*Clathria seriata*, *Spongelia fragilis*, *Sarcodictyon catenata*, *Palmipes membranaceus*, *Stichaster roseus*, *Porania pulvillus*, *Antedon rosaceus*, *Adamsia palliata*, *Crania anomala*, *Pandora inæquivalvis*, *Cynthia echinata*, and the rare little Ascidian *Forbesella tessellata*, and a large number of other species, representing most of the invertebrate groups, which have not yet been sorted out and identified. A list of the species previously found in the neighbourhood of Port Erin will be found in "Fauna of Liverpool Bay," vol. i. pp. 318–41.

The Liverpool Marine Biology Committee's Station at Port Erin is now open, and is provided with a few microscopes, microtome, ordinary reagents, dishes, &c. Any biologists wishing to go there for collecting or other work are requested to apply for particulars to Prof. Herdman, or to Mr. I. C. Thompson, 4 Lord Street, Liverpool.

## *THE ANNUAL VISITATION OF THE GREENWICH OBSERVATORY.*

THE report of the Astronomer-Royal to the Board of Visitors this year commences with a reference to the loss sustained by the Observatory by the death of Sir G. B. Airy, who for sixty years was closely connected with the working of this institution.

As regards the buildings, that of the south wing of the proposed Physical Observatory has been authorized by the Admiralty, considerably more space being required for the storing of chronometers and deck watches. The buildings of the three other wings and the two upper stories of the central tower have, for the present, been laid aside, sufficient provision not being made for them in the present financial year. The new 36-foot dome, which is being provided for the efficient working of the 28-inch refractor, is still in course of erection, while the pair of semi-domes for the Transit Pavilion in the Front Court has been found to be quite satisfactory. The electric light installation, which has in a former report been suggested by the Astronomer-Royal for the photographic equatorial and for other instruments, has been sanctioned by the Admiralty, and will, during the course of the present year, be provided. The advantages of such a means of lighting will at once make themselves apparent, for by the old method the storage cells had to be charged from primary batteries.

The Observatory, by the will of the late Sir George Airy, has had several valuable works bequeathed to it. Mr. Wilfred Airy has as yet transferred 94 volumes and 134 unbound tracts, which will form a valuable addition to the library, together with the manuscript containing the calculations of Sir George Airy's numerical lunar theory. His bust, by Foley, has also been received and is now placed in the Octagon Room.

With regard to the work done with the transit-circle, the number of observations was not so great as in former years, as the object-glass was removed for repolishing on August 10 to October 5. The definition and colour-correction of this glass has been greatly improved by Mr. Simms. New steel screws to the R.A. and Z.D. micrometers were added at the same time, and the wire system also received a slight modification. The wires are ten in number, distant from each other by exact multiples of a screw-revolution, and so arranged that the mean of the ten nearly coincides with one of them. A little computation is thus saved in taking the mean of a transit, and the only thing lost is symmetry in the arrangement.

During the rest of the year the sun, moon, and planets have been regularly observed on the meridian as before:—

| | |
|---|---|
| Transits, the separate limbs being counted as separate observations ... ... ... ... | 4801 |
| Determinations of collimation error ... ... | 249 |
| Determinations of level error ... ... ... | 335 |
| Circle observations ... ... ... ... | 4463 |
| Determinations of nadir point (included in the number of circle observations) ... ... | 319 |
| Reflexion observations of stars (similarly included) ... ... ... ... ... ... | 436 |

The annual catalogue of stars observed in 1891 contains 1813 stars.

The results from the observations for the determination of variation of personal equation with stellar magnitude, indicated that there was a general tendency with all the observers to observe stars later when the light was diminished by placing a gauze screen before the object-glass; but it was stated that "it is not clear that we are here measuring a real change of personal equation in observations of fainter stars, as the introduction of the screen modifies the image of the star, and this modification of the image may give rise to a change of personal equation unconnected with the diminution of brightness."

It is noted that as the external thermometer rises there is a nearly uniform decrease of the readings of the internal thermometers over that of the standard exterior thermometer, the excess vanishing at something over 70°. This is accounted for by the variation of the temperature of the walls of the room, the permanent temperature of which is always slowly changing.

The total number of observations made with the alt-azimuth in the year ending 1892 May 10 is as follows :—

| | |
|---|---|
| Azimuths of the moon and stars ... ... | 345 |
| Azimuths of Mark I. ... ... ... ... | 162 |
| Azimuths of Mark II. ... ... ... ... | 182 |
| Zenith distances of the moon ... ... ... | 166 |
| Zenith distances of Mark I. ... ... ... | 164 |
| Zenith distances of Mark II. ... ... ... | 176 |

These numbers are slightly greater than in recent years, owing to the fact that during August and September, when the transit-circle was under repair, the observations of the moon with the altazimuth were made throughout the lunation instead of being confined to the first and last quarters.

With regard to clocks and chronographs, we may mention that the daily rate of the sidereal standard clock underwent a very considerable disturbance, changing from a daily gain of 1·0s. to that of 2·0s. The cause of this difference was due to some workmen who were fixing a new shelf, the necessary hammering setting up vibrations in the building.

With the reflex zenith tube, eighteen double observations of γ Draconis have been made, but owing to the pressure of work the reductions are not yet complete.

Ten occultations of stars by the uneclipsed moon (8 disappearances and 2 reappearances) and 48 phenomena of Jupiter's satellites have been observed with the equatorials, or with the altazimuth. These observations are completely reduced to 1891 December 31. On the occasion of the partial eclipse of the moon on 1892 May 11, 7 disappearances and 3 reappearances were observed of the faint stars in a list prepared by Mr. Crommelin ; and the times of transit of the shadow over some principal craters were also noted. But it is to be regretted that, although favoured by fine weather on this occasion, the Observatory was seriously crippled in their instrumental equipment, the 13-inch refractor of the south-east equatorial and the Lassell 2-feet reflector being both dismounted.

With the photographic equatorial, 301 plates with a total of 1190 exposures have been taken on 112 nights, many of these being taken for special investigations. Of these, 62 plates were taken to determine the relations between diameter of image, length of exposure, and brightness of the star, the results of which have already appeared in the *Monthly Notices* for January of this year. The discussion indicated that, through a range of exposures corresponding to 8 magnitudes, "the square root of the diameter increases as the logarithm of the exposure ; and further, that for equal photographic effects duration of exposure should vary inversely as the brightness of the star." These results were based on as many as 2200 measures of 150 star images. The *réseaux* seem to have given much trouble, the silver film developing pin-holes, the images of which resemble on the photographic plates those of stars. M. Gautier is now supplying the Observatory with two more, coated this time with a film of collodion, in the hopes that it may be freed from the deficiencies mentioned above. The catalogue which has been undertaken at Greenwich of the guiding stars for the zones + 60° to the pole, + 25° to + 29°, and − 3° to − 5°, is very near completion. The catalogues of places (epoch 1900) are complete for the Greenwich zones + 65° to + 80° (the reductions for the circumpolar region being deferred), also for the zones + 60° to + 64° to be photographed at Rome, and for the Oxford zones + 25° to + 29°. The stars for the San Fernando zone (− 3° to − 5°) have all been selected, and their places have been computed for those between R.A. 12h. and 18h.

*Spectroscopic and Photographic Observations.*—The observations of the displacement of the lines in stellar spectra for the determination of their motion in the line of sight have not this year been regularly continued ; a preliminary discussion of the former observations suggesting that they were affected to some extent by the position of the spectroscope, Vega and Altair were observed during the summer and autumn at as wide a range of hour-angle as possible, and with the spectroscope set to each of the four positions 0°, 90°, 180°, and 270° ; the slit being parallel to the declination circle at 0°. The numbers of observations obtained of the F line in the spectrum of Vega are : at 0°, 39 ; at 90°, 42 ; at 180°, 36 ; and at 270°, 39 ; and of the F line in the spectrum of Altair : at 0°, 30 ; at 90°, 32 ; at 180°, 26 ; and at 270°, 29. The measures are now under discussion, and give clear indications of the existence of the systematic error referred to. The observations were interrupted by the dismounting of the 12¾-inch telescope on 1891 November 19.

At the appearance of the new star in Auriga the south-east equatorial was unfortunately dismounted, but the object-glass presented to the Observatory by Sir Henry Thompson was mounted as quickly as possible on the Thompson telescope ; but alterations of the telescope tube were found necessary to bring the spectrum to focus on the photographic plate, and before these could be completed, the Nova had become nearly too faint for observation.

For the year 1891, 360 out of 365 photographs of the sun's surface have been selected for measurement ; 136 of these were sent to the Solar Physics Committee from India and Mauritius.

The solar activity has increased in a remarkable manner during the past year. While there were 175 days without spots in the year 1890, there were only 21 such days in 1891, and since 1891 March 28, the sun has not been free from spots on a single day on which it has been observed. The number of groups visible on the disk at the same time, and their average size and complexity, have all greatly increased during the past twelve months, the group of February 5–18 being the largest ever photographed at Greenwich. This group has had an unusually long life, appearing first on 1891 November 15, and persisting till 1892 March 17.

*Magnetic Observations.*—The continuous register by photography of the magnetic elements has been satisfactorily maintained. It has been found that serious disturbances of the earth-current registers is due to the trains of the City and South London Electric Railway, situated at a distance of 2½ miles from the nearest earth plate, and about 4½ miles from the Observatory. The change of potential takes place every two or three minutes, varying in amount from "a small fraction of a volt to one-third of a volt or more."

The following are the principal results for the magnetic elements for 1891 :—

| | |
|---|---|
| Mean declination (approximate) ... ... ... | 17° 23′ West. |
| Mean horizontal force ... | 3·9587 (in British units).<br>1·8253 (in Metric units). |
| Mean dip ... ... ... ... ... | 67° 19′ 49″ (by 9-inch needles).<br>67° 21′ 0″ (by 6-inch needles).<br>67° 23′ 22″ (by 3-inch needles). |

In the year 1891 there were five days of great magnetic disturbance, but there were also about twenty other days of lesser disturbance, for which tracings of the photographic curves will be published ; these days having been selected in concert with M. Mascart according to the arrangement mentioned in the last report. The calculation of diurnal inequalities from five typical quiet days in each month, commenced in 1889 at Prof. Rücker's suggestion, has been continued.

From February 13 to 14 a very large disturbance was recorded, commencing a day after the large sun-spot was on the central meridian. Considerable magnetic disturbances also occurred on March 6, 11, and 12. Other disturbances occurred on 1891 September 9, 1892 April 25–26 and May 1, and may perhaps "be connected with spots then on the sun's disk."

*Meteorological Observations.*—The mean temperature of the year 1891 was 48°·4, being 1°·1 below the average

of the fifty years, 1841-1890. The highest air temperature in the shade was 85°·1 on July 17, and the lowest 12°·0 on January 10. The mean monthly temperature in 1891 was below the average in all months excepting June, September, October, December. In January it was below the average by 4°·4, in April and August by 3°·0, and in May by 2°·8.

The mean daily motion of the air in 1891 was 278 miles, being 4 miles below the average of the preceding twenty-four years. The greatest daily motion was 960 miles on December 10, and the least 34 miles on February 23 and 24. The greatest pressure registered was 31·5 lbs. on the square foot on November 11. On December 10 the pressure plate was not in action.

The number of hours of bright sunshine recorded during 1891 by the Campbell-Stokes sunshine instrument was 1222, which is about 66 hours below the average of the preceding fourteen years, after making allowance for difference of the indications with the Campbell and Campbell-Stokes instruments respectively. The aggregate number of hours during which the sun was above the horizon was 4454, so that the mean proportion of sunshine for the year was 0·274, constant sunshine being represented by 1.

The rainfall in 1891 was 25·0 inches, being 0·5 inches above the average of the preceding fifty years.

*Chronometers, Time Signals, and Longitude Operations.*—The number of chronometers and deck watches now being tested at the Observatory is 157 (91 box chronometers, 19 pocket chronometers, and 47 deck watches). The annual competitive trial of chronometers commences on July 2, and the trial of deck watches on October 22.

In the year ending 1891 May 10, the average daily number of chronometers and deck watches being regularly rated was 243, the total number received was 765, the total issued 750, and the number set to repair 442.

At the annual trial of chronometers the performance was good, the average trial number of the first six was 21·4, which compares favourably with those of previous years.

The dropping of the time-balls is next referred to. The Greenwich one was not raised on October 14, December 10 and 13, 1891, owing to the violence of the wind; on April 1, 1892, the springs of the mean solar clock failed to act, and on October 19 and November 22 failure in the connections was the cause.

The return signal from Deal was interrupted last November several times, owing to an accumulation of grease which had been applied to the piston. Signals from Devonport clock failed on 51 days, and those from the Westminster clock on 14 days.

The publication of the observations for the Paris-Greenwich longitude in 1888, and of those for the Dunkerque-Greenwich longitude in 1889, has been delayed pending a redetermination of the former longitude which was commenced on June 6 of the present year; and it is hoped to settle several questions of importance raised by the discussion of the results obtained in 1888.

The first stage of the operations for the longitudes Montreal-Canso-Waterville-Greenwich was completed on May 23. The time of transmission along the cable Waterville-Canso was about a quarter of a second—a result confirmed by a rough comparison of signals on 1892 May 11. Prof. McLeod, of Montreal, paid a similar preliminary visit to Canso in 1891 June, and found an accordant value for the time of transmission. Four portable transits were used for the time determinations. These latter were made in all on 14 nights at Greenwich, 12 at Waterville, and about the same number at Canso and Montreal. The preliminary reduction gives every promise of satisfactory accuracy at Greenwich and Waterville.

Captain Grant, R.E., has been at work at the Observatory practising the requisite transit observations for determining the boundary of Mashonaland.

In the Astronomer-Royal's general remarks at the conclusion of his report, he refers to a plan he has devised for making observations out of the meridian with a transit-circle. He proposes to have it so constructed that by means of a turn-table it can be placed and firmly fixed in certain definite azimuthal, the instrument "being used essentially as a transit-circle for a complete series of observations in the selected azimuths plane." This instrument, as he says, would advantageously replace the existing altazimuth, and could be used "not only for the important object of making extra-meridian observations of the moon but also for observations of the sun, planets, and stars (in the meridian as well as out of the meridian), for the elimination, as far as practicable, of systematic errors, and for the more accurate determination of astronomical constants." The aperture of the instrument he suggests should be 8 inches, with circles of 3 feet diameter, read by four microscopes, and he thinks that a suitable position for it could be found about 90 feet north of the declination magnet, where "an unobstructed view could be secured by mounting it with its axis at a height of about 20 feet above the ground."

## NOTES.

THE Ladies' *Soirée* of the Royal Society is being held this evening as NATURE goes to press.

THE annual meeting of the American Association for the Advancement of Science will be held at Rochester, N.Y., from August 18 to 24.

THE late Dr. W. J. Walker placed at the disposal of the Boston Society of Natural History a grand honorary prize "for such investigation or discovery as may seem to deserve it, provided such investigation or discovery shall have been made known or published in the United States at least one year previous to the time of award." This prize has been unanimously awarded to Prof. James D. Dana. In recognition of the value of Prof. Dana's scientific work, and in testimony of the Society's high appreciation of his services to science, the maximum sum of one thousand dollars has been awarded.

IN the new number of the Journal of the Marine Biological Association Mr. Ernest W. L. Holt gives an interesting account of the work he has lately done in connection with his North Sea investigations. The objects of these investigations, as explained in the report of Mr. Calderwood, the Director of the Plymouth Laboratory, are:—(1) to prepare a history of the North Sea trawling grounds, comparing the present condition with the condition say twenty or thirty years ago, when comparatively few boats were at work; (2) to continue, verify, and extend operations as to the average sizes at which the various food-fishes become sexually mature; (3) to collect statistics as to the sizes of all the fish captured in the vicinity of the Dogger Banks and the region lying to the eastward, so that the number of immature fish annually captured may be estimated; (4) to make experiments with beam trawl nets of various meshes, with a view to determine the relation, if any, between size of mesh and size of fish taken. It is obvious that a considerable time must elapse before trustworthy data can be collected on all these points by one inquirer. Mr. Calderwood therefore notes that in Mr. Holt's early reports it has been thought advisable not to treat each heading in detail, since one season of the year may be more suitable for collecting information on one point than on another, but rather simply to state the results of work accomplished. During the spawning season most attention must necessarily be given to heading No. 2, so that in Mr. Holt's present report the relation of size to immaturity is principally mentioned. Work of a similar nature done by Mr. Holt himself in Ireland, by Dr. Fulton in Scotland,

and by observers at Plymouth, shows that a very considerable variation takes place in the sizes at which fishes become sexually mature in different localities, and Mr. Calderwood thinks it is probably not too much to say that as surely as legislation will have to be resorted to for the preservation of fish until they have spawned, so surely will the matter have to be studied for each coast separately.

MR. CALDERWOOD records in his report that the demand on the Plymouth Laboratory for specimens to be used in laboratories and museums throughout the country increases, and requires constant attention. The Laboratory can supply specimens which, in very many cases, could not otherwise be obtained. The proper preservation of certain classes of soft animals is in itself an art developed during the last fifteen years, almost entirely by the persevering efforts of Signor Lo Bianco, of Naples. Within the past year these methods have been published, and it is hoped that with practice the specimens sent out from the Plymouth Laboratory may gradually gain the character so long possessed by the Naples specimens alone.

AT the general monthly meeting of the Royal Institution on Monday, June 13, the special thanks of the members were returned for the following donations :—Mrs. Bloomfield Moore, £80, Sir David Salomons, Bart., £50, Mr. Charles Hawksley, £50, for carrying on investigations on liquid oxygen.

A COMMITTEE appointed by the Botanical Club of Washington to consider the questions of a botanical congress and botanical nomenclature has lately presented its report, which the Club has unanimously adopted. While favouring the final settlement of disputed questions by means of an international congress, the committee do not regard the present as an opportune time. They recommend the reference of the question of plant nomenclature first to a representative body of American botanists, and suggest the consideration, by such a body, of various questions. Among these questions are the following: the law of priority, an initial date for genera, an initial date for species, the principle "once a synonym always a synonym," what constitutes publication?, the form of ordinal and tribal names, and the method of citing authorities.

THE anticyclone, which at the time of our last issue had lain over these islands for some days, then began gradually to give way, and in the night of the 9th northerly winds and cloudy weather set in over Scotland, while depressions formed over England, causing thunderstorms in this country and in Ireland, with heavy rainfall in places, as much as 1·1 inch being measured at Mullaghmore during the twenty-four hours ending 8h. a.m. on Saturday, the 11th. These changes in the distribution of pressure caused great fluctuations of temperature; the maxima observed over Scotland on the 10th were in some cases as much as 30° lower than those of the previous day, while in England, on the 11th and 12th, a still larger decrease of temperature was experienced. A small depression which lay over the south-east of England on Sunday, caused a steady rain for some hours in that part of the country; the maximum temperature registered in London was 51°, being about 18° below the average maximum for June. In fact, so low a maximum temperature has not occurred in London, in June, for at least a quarter of a century. On the night of the 19th the temperature on the grass fell to 29° at Oxford. During the early part of the present week an anticyclone, lying to the westward, extended over the western and northern parts of the country, and a large depression appeared to the southward of these islands, causing moderate northerly and north-easterly breezes, while temperatures continued low in all parts of the country.

THE Meteorological Council have just issued, as the completing portion of the *Weekly Weather Report* for 1891, tables giving improved monthly and annual means of temperature, rainfall, and bright sunshine for all the stations (65 in number) used in the preparation of that publication. The large amount of labour expended on the calculations, and the trustworthiness of the values may be judged of from the fact that the temperature means extend over 20 years, the rainfall over 25 years, and the sunshine over 10 years. A glance at the figures at any station is sufficient to show the chief characteristics of its climate, as compared with any other locality. They show that London has the highest mean maximum temperature in July, 72°·4; Cambridge, the lowest mean minimum, 31°·6 in December, although several other stations have a mean minimum of 31°·7 in that month, and Cambridge and Hillington have 31°·7 and 31°·8 respectively in January. The wettest station is Laudale, N.B., with an annual rainfall of 79°·57 inches, and the driest, Spurn Head, 20·92 inches. The stations with most and least sunshine are Jersey and Glasgow respectively, the deficiency of the latter being due to smoke.

DR. J. HANN laid before the Academy of Sciences at Vienna, on May 5, another of those elaborate investigations for which he is so well-known, entitled "Further Researches into the Daily Oscillations of the Barometer." The first section of the work deals with a thorough analysis of the barometric oscillations on mountain summits and in valleys, for different seasons, for which he has calculated the daily harmonic constituents, and given a full description of the phenomena, showing how the amplitude of the single daily oscillation first decreases with increasing altitude, and then increases again with a higher elevation. The epochs of the phases are reversed at about 6000 feet above sea-level as compared with those on the plains. The minimum on the summits occurs about 6h. a.m., and in the valleys between 3h. and 4h. p.m. The double daily oscillation shows, in relation to its amplitude on the summits, nearly the normal decrease, in proportion to the decreasing pressure, but the epochs of the phases exhibit a retardation on the summits, of as much as one or two hours. In the tropics, however, this retardation is very small. He then endeavours to show that these modifications of the daily barometric range on mountain summits are generally explained by the differences of temperature in the lower strata of air. In connection with this part of the subject, he considers that even the differences in the daily oscillations at Greenwich and Kew are mostly explained by the different altitude of the two stations, and by the fact that Greenwich is on an open hill. In the second section he has computed the harmonic constants for a large number of stations not contained in his former treatise of a similar nature, including some valuable observations supplied by the Brazilian Telegraph Administration, and others at various remote parts of the globe.

A SECOND attempt is to be made to build an Observatory at the top of Mont Blanc. As the workmen who tunnelled last year through the snow just below the summit did not come upon rock, M. Janssen has decided that the building shall be erected on the frozen snow. A wooden cabin was put up, as an experiment, at the end of last summer, and in January and early in the spring it was found that no movement had occurred. According to the Lucerne correspondent of the *Times*, the Observatory is to be a wooden building 8 metres long and 4 metres wide, and consisting of two floors, each with two rooms. The lower floor, which is to be embedded in the snow, will be placed a the disposition of climbers and guides, and the upper floor reserved for the purposes of the Observatory. The roof, which is to be almost flat, will be furnished with a balustrade, running round it, together with a cupola for observations. The whole building will rest upon six powerful screw-jacks, so that the equilibrium may be restored if there be any displacement of the snow foundations. The building is now being made in Paris, and will shortly be brought in sections to Chamounix. The transport of the building from Chamounix to the summit of

Mont Blanc and its erection there have been intrusted to the charge of two capable guides—Frederick Payot and Jules Bossonay.

LECTURES on subjects of great practical interest are being delivered daily in connection with the International Horticultural Exhibition. Mr. H. Cheshire will lecture to-day on "Guano: its origin and composition, use and abuse." Among the subjects of other lectures for which arrangements have been made are "The relation of insects to flowers," "Strawberry culture," and "The tomato: its diseases," by Prof. F. L. Cheshire; "Hatching: the management of the brooding hen," by Mr. W. Cook; and "Plant food and the formation of composts," by Mr. H. Cheshire.

DR. W. L. ABBOT has prepared for the Smithsonian Institution an excellent descriptive catalogue of the collection of ethnographical objects from Kilima-Njaro, presented by him to the National Museum. Dr. Abbot expresses his belief that Kilima-Njaro, with its cool, healthy, and bracing climate, will some day be a great sanatorium for Europeans from the hot and fever-stricken coast regions. He would be sorry, however, to see civilization invade this region, and hopes the day may be far distant when a railway shall open the way into the interior, and drive off "the herds of game that still pasture within sight of Africa's great snow mountains."

MESSRS. JOSEPH BAER AND CO., booksellers, Frankfort, are selling the botanical library of the late Prof. L. Just, director of the botanical garden connected with the Polytechnicum at Carlsruhe. The list includes many important works in various departments of botanical science.

MR. L. RYBOT writes to us from Southampton that he caught a very perfect specimen of the rare crimson speckled *Deiopeia pulchella*, on the afternoon of Friday last (June 10), in a field on the right bank of the Itchen, not far from Southampton.

IN 1874 the British Association published a volume of "Notes and Queries on Anthropology," the object being to promote accurate anthropological observation on the part of travellers, and to enable those who were not anthropologists themselves to supply information wanted for the scientific study of anthropology at home. A second edition has long been wanted, and a Committee was appointed by the British Association to consider and report on the best means for bringing the volume up to the requirements of the present time. The Committee recommended that the work should be transferred to the Anthropological Institute, and this proposal was accepted, the Association making grants amounting to £70 to aid in defraying the cost of publication. The new edition has now been issued, the editors being Dr. J. G. Garson and Mr. C. H. Read; and every one who may have occasion to use it will find it thorough and most suggestive. The first part—Anthropography—has been entirely recast; the second part—Ethnography—has been revised, and additional chapters have been written. Among the contributors to the volume are Mr. F. Galton, Mr. A. W. Franks, Dr. E. B. Tylor, General Pitt-Rivers, and many other well-known authorities.

MR. CYRUS THOMAS announces in *Science*, of May 27, that he has discovered the key which will unlock the mystery of the Maya codices, and, probably, the Central American inscriptions. The progress of decipherment will be slow, but he is confident that it will be ultimately accomplished. He has already determined the signification of some dozens of characters, and in several instances ascertained the general sense of a group forming a sentence, although there are a number of conventional symbols. Mr. Thomas holds that the great majority of the characters are truly phonetic, and that the writing is of a higher grade than has hitherto been supposed.

THE members of the Johns Hopkins Marine Station accumulated during the summer of 1891, in addition to the results of their special researches, many general observations upon the fauna of Jamaica. These notes are printed in the April number of the Johns Hopkins University Circulars, and will be of considerable service to any one who may desire to obtain what is called in the Circular "a preliminary view of the material."

THE new number of the *Internationales Archiv für Ethnographie*, contains interesting notes (in English) by A. Ernst, Caracas, on some stone-yokes from Mexico. R. Parkinson contributes (in German) a paper on tattooing among the natives of the district Siarr, on the east coast of New Mecklenburg, New Ireland. A paper on the development and geographical distribution of the various types of building in use among Finnish peoples is contributed by Axel O. Heikel, of Helsingfors. The illustrations, as usual, have been carefully prepared.

THE Society for Promoting Christian Knowledge has issued a fresh series of coloured representations of plants. They have been printed in Germany, and ought to be of good service to students and teachers of botany.

THE first volume of "A Treatise on Hygiene," edited by Dr. Thomas Stevenson and Mr. Shirley F. Murphy, will shortly be issued by Messrs. J. and A. Churchill. It consists of articles, by eminent writers, on many different phases of hygienic science. The second volume is in the press.

MR. C. F. MABERY gives in *Science*, of May 13, a full account of the new chemical laboratory of the Case School of Applied Science, Cleveland, Ohio. In devising plans for the laboratory, Mr. Mabery felt that while it was not good economy to construct a building several times larger than present needs demanded, it was important to provide for the possibility of unlimited extension. A plain, rectangular form was therefore designed, and it was found that extension of the main hall into a wing of any size would not interfere with a convenient arrangement of the rooms for present use.

ICEBERGS seem to be unusually plentiful in the Atlantic this year. According to a writer in the *Times*, the log of the Inman liner *City of Berlin*, which arrived on the 3rd inst., shows how dangerously close to the Transatlantic path the icebergs are hovering. On the afternoon of May 31, about 5.45 o'clock, the *City of Berlin* was in latitude 50° 20′, longitude 42° 15′. It was a clear and pleasant evening, and almost all the passengers were on deck. About 5 o'clock the air became very chilly, and the temperature of the water was very low. Captain Land at once suspected icebergs, and steered a more southerly course in the hope of avoiding them. About 6 o'clock, only a few miles to the north, a towering double-pinnacled berg was sighted. The berg was fully 200 feet high and about 600 feet long. Twenty minutes later another berg was sighted on a direct line with the first; between 6 and 8.30 o'clock four bergs were sighted. None of them was less than 100 feet high and 300 feet long; all were in a good state of preservation, and looked as though they would be able to drift about for some time. Icebergs have also been sighted by other vessels.

THE Todas, inhabiting the Nilgiri plateau, are not dying out gradually, as has long been supposed. The last census figures show that they have increased by no less than 10 per cent. during the last ten years, there being now nearly eight hundred of them altogether.

IN the new number of the Journal of the Straits Branch of the Royal Asiatic Society there is an interesting note on the little insectivore, *Tupaia javanensis*. It is very common in Singapore, and especially in the Botanic Gardens, where it may be often seen running about among the trees. It is easily mis-

taken for the common little squirrel (*Sciurus hippurus*), of which it has much the appearance. When alarmed it quickly darts up the trunk of the nearest tree, but it is a poor climber, and never seems to go high up like the squirrel. Besides these points of resemblance, it appears to be largely frugivorous. It was found that the seeds sown in boxes were constantly being dug up and devoured by some animal, and traps baited with pieces of coco-nut or banana were set, and a number of tupaias were caught. These being put into a cage appear to live very comfortably upon bananas, pine-apple, rice, and other such things; refusing meat. The Rev. T. G. Wood, in his "Natural History," states that *T. ferruginea* is said to feed on beetles, but to vary its diet with certain fruits. The common species at Singapore seems to be almost entirely frugivorous, though its teeth are those of a typical insectivore.

THE thirtieth Bulletin of the Botanical Department, Jamaica, contains a careful paper, which ought be be very useful, on the sugar-cane borer, by which much damage is being done in sugar plantations. The author is Mr. T. D. A. Cockerell, Curator of the Institute of Jamaica. Another contributor to the Bulletin, writing of gardening in Jamaica, mentions that about a year ago Messrs. Cannel and Sons, Swanly, Kent, sent her some small plants of chrysanthemums by post. They were all new and valuable; and the English season being so short, Messrs. Cannel and Sons begged her to try whether she could succeed in getting seed from these for them, offering to send her a collection of choice chrysanthemums in repayment of her trouble should she be successful. Out of the six plants one died, killed by a grub; the rest turned out magnificent, blowing with a profusion such as she had seldom seen before—they were perfect umbrellas of bloom; but the flowers died off without seeding. The plants then threw out a perfect little forest of offsets, and she finds that any cuttings broken off from the old plants will root easily.

A METHOD of rabbit-destruction which has been tried with considerable success in the Hay district, is recommended by the *Agricultural Gazette of New South Wales* as worthy of the consideration of pastoralists throughout the colony, more especially where the rainfall is light. The destroying agent is poisoned water, which is prepared as follows:—Cover 1 ounce of strychnine with concentrated hydrochloric acid, or what is commonly known as strong muriatic acid or spirits of salts, and leave to soak all night. The mixture easily dissolves in half a gallon of boiling water. After making the solution, bottle off and use as required. A pint of the mixture will poison 60 gallons of cold water; possibly a weaker mixture might be efficacious. This system has been adopted at Benerembah Station, sixteen shallow 8- to 10-gallon troughs being used to each tank, and the number of rabbits poisoned at each tank nightly is stated to be 10,000. In the Mossgiel district no less than 27,000 rabbits were destroyed in two weeks by the use of poisoned water.

THE idea of flower-farming for perfumes seems to be exciting a good deal of interest in New South Wales, as many inquiries on the subject have lately been submitted to the Agricultural Department. There are at present in the colony no means of illustrating the practical operations of this industry, but the *Agricultural Gazette of New South Wales* hopes that this deficiency will soon be supplied by the institution of experimental plots on one or more of the experimental farms. The *Gazette* points out that in scent farms large quantities of waste material from nurseries, gardens, orchards, and ordinary farms might be profitably utilized, while occupation would be found for some who are unfit for hard manual labour. A Government perfume farm was lately established at Dunolly, in Victoria, and this promises to be remarkably successful.

AT the meeting of the Field Naturalists' Club of Victoria on March 14, Prof. Baldwin Spencer, the President, gave an interesting account of a trip he had made to Queensland in search of Ceratodus. Special interest attaches to this form, since it is the Australian representative of a small group of animals (the Dipnoi) which is intermediate between the fishes and the amphibia. Ceratodus has its home in the Mary and Burnett Rivers in Queensland, whilst its ally, Lepidosiren, is found in the Amazon, and another relative, Protopterus, flourishes in the waters of tropical Africa. Although unsuccessful in obtaining the eggs of Ceratodus, owing to the early season, Prof. Spencer was able, from a careful study of the surroundings under which the animal lives, to infer that its lung is of as great a service to it during the wet as during the dry season—a theory in direct opposition to the generally accepted one that the lung functions principally during the dry season, when the animal is inhabiting a mud-cocoon within the dry bed of the river.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. Oswald Norman; a Common Fox (*Canis vulpes*), British, presented by Mrs. Onslow Wakeford; two Four-horned Antelopes (*Tetraceros quadricornis* ♀ ♀) from India, presented by Mr. W. F. Sinclair; a Magellanic Goose (*Bernicla magellanica*) from the Falkland Islands, presented by the Rev. J. Chaloner; six Common Lizards (*Lacerta vivipara*), a Slowworm (*Anguis fragilis*), British, presented by Mr. Percy W. Farmborough; three Little Green-winged Doves (*Chalcophaps chrysochlora*) from North Queensland, deposited; two Diamond Snakes (*Morelia spilotes*), a Punctulated Tree Snake (*Dendrophis punctulatus*), a Bearded Lizard (*Amphibolurus barbatus*), a Burton's Lizard (*Lialis burtoni*) from Australia, received in exchange; a Great Kangaroo (*Macropus giganteus*), born in the Gardens.

## *OUR ASTRONOMICAL COLUMN.*

THE LATE NEW STAR IN AURIGA.—A very interesting table, showing a summary of all the observations made with regard to the magnitude of the late new star in Auriga, will be found in *L'Astronomie* for June. Commencing with the photographs taken by Prof. Pickering, when the Nova was very nearly of the 12th magnitude, the table shows a tremendous increase of brilliancy up to December 18, when it had reached a maximum, its magnitude then being about 4·5. From that date to March 2, the diminution in intensity was only very slight, being reduced only by about one magnitude, but, subsequent to this, the fading was nearly as rapid as the brightening, the star diminishing, on an average, a magnitude in a period of about 3·2 days.

PHOTOGRAPHIC MEASURES OF THE PLEIADES.—The third number of the "Contributions from the Observatory of Columbia College, New York," consists of the Rutherfurd photographic measures of the group of the Pleiades reduced by Mr. Harold Jacoby. These photographs were among the complete set of original negatives that were presented to this Observatory by Mr. Rutherfurd, and were taken in the years 1872 and 1874. This special group was chosen for reduction in order to investigate the accuracy obtainable by the methods employed, and the results show that the reduced places can be thoroughly relied upon. The table containing a catalogue of the stars in question gives the places for the epoch 1873·0, together with the precessional and secular variation. In the discussion of the results, the Yale and Königsberg heliometer measures have been used for the sake of comparison, and Mr. Jacoby clearly demonstrates that the photographic results are of very considerable accuracy. Taking the case of the right ascensions, the difference of the residuals, obtained from the Yale and New York results, and those from Yale and Königsberg, amounts in only two cases to as much as 0″·50, while the mean may be roughly estimated as less than 0″·25. That part of the table relating to the declinations furnishes equally satisfactory values, showing us that, for any future study regarding the determination of proper motions in this region, these photographic observations ought to be taken into account. The average probable errors in right ascension

and declination amount to ± 0″·05 and ± 0″·05 respectively; the actual probable errors somewhat exceeding these values, as they involve the scale inaccuracies and other possible sources of error.

THE PLANET MARS.—In the early morning Mars is now visible on our eastern horizon. This period of 1892 will be the most favourable for observation that we have had since the year 1877. The opposition takes place on August 4 next, when the planet is near perihelion, so that its proximity to us will not be quite so great as was the case in 1877. The longitude of the planet at the time of its perihelion passage will be 333° 49′, but our earth will not reach this until August 27. The apparent diameter on the 18th of this month will amount to 17″·66, while on August 5 it will be 24″·78; the phases for these two dates will be respectively 1″·34 and 0″·05. The positions for the 17th, 21st, and 25th of this month are as follows:—

| June | R. A. | Decl. |
|---|---|---|
| 17 ... ... | 21h. 16m. ... ... | − 20° 4′ |
| 21 ... ... | 21h. 20m. ... ... | 20° 7′ |
| 25 ... ... | 21h. 22m. ... ... | 20° 13′ |

*L'Astronomie* for June contains a very interesting article by M. Camille Flammarion, in which some quite recent observations of this planet are inserted. There are also several illustrations of the physical features, including the new map by M. Lohse and the drawings made by M. Nieston during the year 1888.

## GEOGRAPHICAL NOTES.

THE French Ministry of Public Instruction has authorized M. Ch. Almand, of the Natural History Museum of Limoges, to study the Seychelles Islands in detail with special reference to their fauna.

THE Geographical Society of Lima has just issued the last number of the first volume of its *Boletin*, a most creditable publication containing many articles bearing on the geography of Peru and the Andes. Amongst the more important papers in the current issue are a monograph on Lake Titicaca, a discussion of the climatology of Peru, by Dr. Luis Carranza, and the report of a recent Commission sent out by the Peruvian Government to inspect the new road across the Andes leading to the highest navigable point on the eastern rivers. The road starting from Chicla, the temporary terminus of the Oroya railway, crosses the watershed at Casapalca at 17,500 feet of elevation, passes Tarma, Palca, La Merced, and thence runs northward through a little-known region inhabited by native tribes to Puerto Tucker, at the junction of the Pichis with the navigable tributaries of the Ucayali. In referring to this road at a recent meeting of the Royal Geographical Society, the Peruvian Consul pointed out that it would be easy, if a railway were constructed following the line of this road, and connecting steamers run on the Amazon and Ucayali, to reach Lima from London in twenty days instead of a month as is now necessary. Other papers in the *Boletin* deal with the archæology of the Andes region; all branches of geography being well represented.

A NEW Russian Expedition to Eastern Tibet and Sze-chuan in China has been decided on, and will set out next year, under the leadership of M. Potanin. It is intended to spend three years in the exploration, a sum of 30,000 rubles (about £3000) being granted by the Russian Government towards the expenses. Capt. Roboroffski accompanies the expedition, on the staff of which various scientific specialists will also be placed.

AT the May meeting of the Paris Société de Géographie the great gold medal was presented to M. Elisée Reclus for his "Nouvelle Géographie Universelle," a work which, though unfinished, is of unique value, and is respected and consulted in all countries. This award is significant of the feeling that careful and conscientious collation and generalization of the work of explorers and travellers occupies a much higher place in the science of geography than has been hitherto accorded it. Amongst those to whom other gold medals were awarded are the Prince of Monaco, for oceanographical research; M. A. Paine, for explorations in Indo-China; M. J. de Morgan, for travels in Persia and Kurdistan; M. H. Coudreau, for ten years of exploration in the interior of French Guiana; and M. Alfred Fourneau, for exploration in French Congo.

## NAPLES ACADEMY OF SCIENCES.[1]

THIS volume has been much delayed on account of a memoir by Prof. Trinchese on *Rhodope veranii*. That paper should have constituted the first of the present volume, but a notice leaf after the title-page informs us that it will be sent later on as a separate pamphlet. In consequence the volume starts with an elaborate paper in French, of 72 pages and three plates, by M. S. Kantor, "Sur la solution canonique du problème des transformations birationnelles périodiques," iv.e partie. This memoir treats of "Méthodes et problèmes; les caractéristiques internes et les caractéristiques permutables; les caractéristiques à 6, 7, 8 points; théorie arithmétique des caractéristiques de transformations birationnelles; les complex anallagmatiques de singularités et de la réductibilité des caractéristiques par équivalence birationnelles; les groupes impropres; les matrices birationnelles de M. de Jonquière; et sur plusieurs groupes de caractéristiques et de transformations."

Prof. F. Bassani contributes a paper on the Miocene Ichthyolites of Sardinia, from specimens collected and placed in his hands by Prof. Lovisato. The tables, cross references, and index are admirable, and of great use to specialists in this branch. Many of our English workers, and above all, Societies, should take a lesson from this. It is occasionaliy the author of a paper, but far more frequently the responsible authorities of some scientific body, that are the cause of such valuable details not appearing in a paper. How often does it occur that for a paltry economy, a valuable memoir is cast upon the world a dismembered trunk, little comprehensible to the reader, and often a curse to the writer, who is exposed to all sorts of absurd criticisms because his original statements have been pruned to deformed stumps and his tables entirely suppressed.

Several old species are more fully illustrated by descriptions and neat plates drawn by Mrs. Bassani, as well as a new species of Thyrsites, Thynnus, Lamna, Myliobatis, &c.

Prof. Eugenio Scacchi has a memoir on the crystallography of certain new salts obtained by Prof. F. Mauro. The fluoximolybdate of copper is found to be monoclinic. Hypofluoximolybdate of copper is also monoclinic, whilst the hypofluoximolybdate of zinc is rhombohedral. Observations were difficult on account of the great deliquescence of these salts. The memoir is accompanied by one plate of crystal drawings.

Dr. Otto Schmiedeknecht, on his return from an entomological excursion to the Ionian Islands, placed in the hands of Prof. A. Costa all the Tenthredinidæ and Cephina that he had collected there. Prof. Costa describes these under 68 species, 9 of which are new. This is followed by a new genus of Italian Tenthredinidæ, named Laurentia, represented by the species *Laurentia Craverii*. The third section of this "Miscellanea Entomologica" is constituted by the description of four species of Armenian Hymenoptera: *Hylotoma cyanura*, *Allantus violaceipennis*, *Lissonota ducalis*, and *Lissonota decorata*. The "Miscellanea Entomologica" terminates with a new African Blattid, the *Derocalymma Brunneriana*, and is illustrated by one plate of figures in black.

Prof. G. Nicolucci, in a "Glimpse at the Ethnology of Egypt," discusses the different theories concerning the origin of the ancient Egyptians. By comparing the results obtained from historical records, monuments, anatomical observations, and descriptions of the people by ancient writers, he concludes (1) that the Egyptians belong to a white family related in prehistoric times to a Semitic branch; (2) that their physical characters form a type apart, which is clearly revealed in the monuments and the skulls obtained from the tombs of all periods; (3) that this type is the purer the more remote is the period of the monuments; (4) that it is true the immigration of other people into Egypt modified in part the primitive type of the population, but that the principal part of the Egyptians have always retained their primitive characters; (5) at the present, although the type has been crossed by intermarriage with different people in the cities, and other points frequented by strangers, it retains its original character in the Fellah, who are the true and legitimate modern descendants of the constructors of the Pyramids.

Prof. Nicolucci considers the Copts to be descended from ancient Egyptians, but with some infiltration of negro blood. The paper is accompanied by two plates, one of several modern Egyptian types, and one of the portrait of Rameses II. side by side with that of a Fellah.

[1] *Atti della Reale Accademia delle Scienze Fisiche e Matematiche di Napoli*, Serie Seconda, vol. iv., Napoli, 1891.

Signor G. F. Mazzarelli contributes some researches on the morphology and physiology of the glands of Bohadsch in the Aplysiidæ (the opaline gland of Vayssière). He also gives the diagnosis of a new species of Aplysia. The author gives an elaborate histological description of the organ illustrated by two coloured plates, and amongst other conclusions shows that three liquids are secreted—a white odoriferous, a violet, and a mucous—which he declares to have an important biological value, and to concur with the secretions of the mantle for the defence of the animal.

Dr. N. Terracciano in a note on some plants of the flora of Terra de Lavoro describes several species so far not met with in that district, others not included in the Italian flora, and some new species and varieties. Figures are given of *Arabis surculosa*, *Amaranthus crispus*, and *Kœleria collina*.

Next follows a monograph of the fossil Pristis, with a description of a new species (*Pristis lyceenis*) from the Miocene limestone of Lecce, and of course figured.

Dr. L. Manfredi has an interesting paper on the contamination of the street surface of large cities, from a hygienic and sanitary engineer's point of view, with special reference to Naples. Sweepings of the streets were made at 9 a.m.—that is, after the regular cleansing had been performed, so that the materials collected represented what remains all the day to contaminate the air and whatever objects it comes in contact with. The materials, collected with all due precautions, were submitted to bacteriological and chemical analysis. One gramme of fresh sweepings contains from 910·000 to 668,000,000 vital or living bacteria, or double the amount found in fresh fœces, or about 1319 times richer than drain water. Compared with the streets of Munich we find that the author there found 8000 to 12,840,000. He demonstrates that, so far as Naples goes, the more cleanly kept are the streets the lower is the number of bacteria in their sweepings, whilst they or their spores have great resisting powers to heat, sunlight, and desiccation. They are most abundant in the temperate seasons of spring and autumn ; small rains increase them, torrents markedly diminish them. The Schizomycetes are the predominant type, but ferments and moulds are common. The chemical examination is equally interesting, and, as the author shows, the material is a most favourable culture medium for micro-organisms ; which research leads up to a series of experiments to show how the number of these increase up to a certain date and then diminish in a given sample of sweepings ; the effects of rain in facilitating this growth are demonstrated, and also the gases given off as the result of such changes.

The inoculation experiments are also not without interest. An examination of the sub-soil on the same lines is of great importance, and several practical and important conclusions are drawn from these researches, which the limits of space forbid our more fully reviewing. The memoir is one that should be consulted by every municipal officer.

Signor G. F. Mazzarelli has another long paper on the morphology and physiology of his favourite Aplysiæ of the Gulf of Naples, and illustrated by four plates.

Altogether this volume does credit to the Academy, but one regrets not to see papers by some more of its members.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

OXFORD.—In a Convocation held on June 7, the thanks of the University were ordered to be conveyed to Mr.C. D. E. Fortnum, Hon. D.C.L., for his munificent gift to the Ashmolean Museum, and an indenture was sealed, the provisions of which place the Ashmolean Museum on an entirely new footing.

In the year 1888 Dr. Fortnum gave to the University a large portion of his collection of antiquities and works of art, which had been exhibited on loan in the upper room of the Ashmolean Museum. Dr. Fortnum has now notified his intention of bequeathing to the University the remainder of his collection together with his library, and he has undertaken to transfer to the University a sum of £10,000 on certain conditions, the main object of which is to provide for the care and maintenance of the Museum in the future. Under the indenture, which was signed on Tuesday last, the University is bound—

(1) To provide a sum, not exceeding £11,000, for the erection of a new Ashmolean Museum, on ground adjoining the University Galleries.

(2) To provide a sum, not exceeding £4000, for the fitting up and furnishing the Museum.

(3) To augment to £600 a year, at least, the income arising from Dr. Fortnum's benefaction of £10,000.

Dr. Fortnum's kindly intentions to the new Ashmolean Museum include a further bequest to the University of £5000 contingent upon the University voting the £15,000 for buildings, fitting, and furniture. With regard to this amount the University authorities make the following remark:—"Of the £11,000 required for the building, it appears that the Curators of the University Chest will have funds in hand in the course of this year and next, out of which this expenditure may be defrayed. It is right, however, to state that this will leave the University Chest for the present without further resources, in the form either of stock or of cash, for meeting any other new expenditure upon a large scale."

It is proposed that the old Ashmolean Museum, when no longer required for its present purpose, shall be available as an extension for the Bodleian Library, for which additional accommodation must have soon been provided.

*The University Observatory.*—The annual meeting of the Board of Visitors took place on Wednesday, June 8, when the Savilian Professor (Rev. C. Pritchard, D.D., F.R.S.) read his annual report. After remarking on the present condition of the buildings and instruments, the Professor said :—

"As anticipated in the last report, the work connected with stellar parallax is now complete, and I have placed upon the table a manuscript containing the result of that research. I need hardly say that it has been a work of unremitting labour, and one which has occupied the strenuous efforts of myself and the Observatory staff during the last four years. The manuscript thus completed consists of (1) the concise but complete history of all effective researches in stellar parallax up to the present date ; (2) the results of the parallax work completed in this Observatory, extending on the whole to some thirty stars ; (3) a catalogue of all parallactic determinations effected by other astronomers.

"The provision of photometric catalogues of stars of the ninth and eleventh magnitudes, within small specified areas for the use of the eighteen Observatories engaged on the international chart of the heavens, has been effected, and the results distributed through the agency of the Paris Observatory. The cause of this proceeding originated in the unsuccessful attempts to secure the required uniformity of stellar magnitude on the photographic plates by the employment of metallic gauze screens of one definite mesh. Much time was consumed on the experimental research into the action of such screens on the photographic image, and in the course of the inquiry certain unexpected and interesting results came to light, the substance of which I communicated to the Paris Academy, and which were subsequently published in the Transactions of that body. It is satisfactory to find that these photometric determinations have been appreciated and found to be of practical service, and have been acknowledged as such by both the Directors of the Greenwich and Paris Observatories.

"Notwithstanding these very serious interruptions, considerable progress has been made in securing the photographic plates for the international chart and catalogue. In number these plates amount to about 150, and it is hoped in future they will accumulate more rapidly, since the work on the preparation of these aforementioned photometric catalogues is now complete."

The report concludes with the usual acknowledgments to the assistants, and with this very satisfactory expression, on which we beg to congratulate the Savilian Professor—"The state of my health and other circumstances prevented my being present at the last meeting of the Board, but I am glad to say that the anticipation of the speedy and complete recovery, mentioned in the last report, has been fully realized."

*Radcliffe Travelling Fellowship.*—The Examiners for this Fellowship give notice that a Fellowship is thrown open this year to all persons who have been placed in the First Class in the School of Natural Science, without further restriction. The examination will be as far as possible in the subjects specified by the candidates who offer themselves for examination, and will take place in the first week in November.

## *SOCIETIES AND ACADEMIES.*

LONDON.

**Royal Society, May 19.**—"On the Measurement of the Magnetic Properties of Iron." By Thomas Gray, B.Sc., F.R.S.E. Communicated by Lord Kelvin, P.R.S.

This paper gives the method of experiment and results

obtained in some investigations on the time-rate of rise of current in a circuit having large electromagnetic inertia. The experiments were made on a circuit containing the coils of a large electromagnet having laminated cores and pole pieces. The mean length of the iron circuit was about 250 cm., and its cross section 320 sq. cm. The magnetizing coil had 3840 turns, when all joined in series, and a resistance of 10·4 ohms. The coils were so arranged that they could be joined in a variety of ways so as to vary the resistance, inductive coefficient, &c., and also to allow the magnet to be used either as an open or a closed circuit transformer.

The electromotive force used in the experiments was obtained from a storage battery, and the method of experiment was to trace the curve, giving the relation of current to time, on a cronograph sheet.

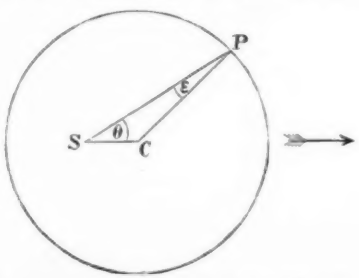
One set of experiments shows the effect of varying the impressed E.M.F. on the time required for the current to attain any given percentage of its maximum strength. The results show that for any particular percentage there is always a particular E.M.F. which takes maximum time. Thus for the circuit under consideration, and with successive repetitions of the current in the same direction, it takes longer time for the current produced by an impressed E.M.F. of 4 volts to reach 95 per cent. of its maximum than it takes for the current produced by either 3 or 5 volts to reach 95 per cent. of their maximum. The results show also that, within considerable limits, the time required for the current to become uniform is on the whole nearly inversely proportional to the impressed E.M.F., and that for moderate values of the E.M.F. the time may be very great; when the E.M.F. was 2 volts, and the current sent in such a direction as to reverse the magnetism left in the magnet by a previous current of the same strength, the time required for the current to establish itself was over three minutes. The difference of time required for repetition and for reversal of previous magnetization was also very marked when the iron circuit was closed. The results show that great errors may arise by the use of ballistic methods of experiment, especially when weak currents are used, and that for testing resistances of circuits containing electromagnets, a saving of time may be obtained by using a battery of considerable E.M.F.

Another set of experiments gives the effect of successive reversals of the impressed E.M.F. at sufficient intervals apart to allow the magnetization to be established in each direction before reversal began. In this set also the effect of cutting out the battery and leaving the magnet circuit closed is illustrated, showing that several minutes may be required for the magnet to lose its magnetism by dissipation of energy in the magnetizing coil. The effect on these cycles of leaving an air space in the iron circuit is also illustrated. It is shown that a comparatively small air space nearly eliminates the residual magnetism, and diminishes considerably the rate of variation of the coefficient of induction and the dissipation of energy in the magnet.

Several cycles are shown for the magnet used as a transformer with different loads on the secondary. The results give evidence that there is less energy dissipated in the iron the greater the load on the secondary of the transformer.

Some experiments are also quoted which go to show that the dissipation of energy due to magnetic retentiveness (magnetic hysteresis) is simply proportional to the total induction produced when the measurements are made by kinetic methods. Reference is made to the recent experiments of Alexander Siemens and others which seem to confirm this view.

**Physical Society**, May 27.—Mr. Walter Baily, Vice-President, in the chair.—The following communication was read:—On the present state of our knowledge of the connection between ether and matter: an historical summary, by Prof. O. J. Lodge, F.R.S. Referring to difficulties connected with the aberration of light, if the medium were supposed to be carried along by the earth in its orbit, Dr. Lodge described Boscovich's suggested experiment with a telescope filled with water, carried out by Klinkerfues, who was led to conclude that the aberration constant depended on the medium within the telescope. Klinkerfues's experiments were repeated by Sir G. B. Airy, but not confirmed. Astronomical observations were not necessary to determine the point at issue, for a fixed source near a collimator might be used with advantage. Hoek had examined the subject in this way with similar negative results. It might therefore be concluded that surveying operations are unaffected by terrestrial motion. This result, however, did not prove the existence or non-existence of an ether drift relative to the earth, for, since the source and receiver move together, any effect produced by such a drift would be compensated by aberration due to motion of the receiver. Speaking of refraction, he pointed out that, if the ether were stationary in space, glass and other terrestrial bodies would have ether streaming through them, and that the refraction of, say, glass might differ as the direction of the ether drift through it varied. To test this, Arago placed an achromatic prism over the object-glass of a telescope on a mural circle, and observed the altitude of stars. To vary the direction of the ether drift through the prisms, stars in different azimuths were observed; but the results showed no appreciable change in the deviation produced by the prism due to direction of the earth's motion. Maxwell used a spectroscope to test the same point. Light from illuminated cross wires passed through the telescope, prisms and collimator, and was reflected back along the same path by a mirror and viewed through the telescope. Observations made with different aspects of instrument showed no change in the relative positions of the wires and their images. Mascart had also tried the experiment with simpler apparatus, but was unable to detect any change. These observations naturally suggest that the ether is at rest relative to the earth, but the apparently simple nature of aberration makes this view difficult to hold. Both phenomena are consistent with Fresnel's hypothesis that only the excess of ether, which the substance possesses over that of surrounding space, moves with the body, for on this supposition the effects of altered refraction and ether drift compensate each other. Fresnel's view is practically established by Fizeau's well-known experiment on the effect of moving water on the velocity of light, and by the more accurate numerical results obtained by Michelson. The only other theory which accounts for the experimental results is one by Prof. J. J. Thomson, which requires that the velocity of light in Fizeau's experiment should be altered by half the velocity of the medium. For media whose refractive indices are $\sqrt{2}$, the two theories lead to the same result, and as the indices of substances such as water do not differ much from this value, it is difficult to discriminate between them. Looked at in another way, Fizeau's experiment raises a difficulty, for, as Dr. Lodge pointed out, all water is moving with the earth, hence light should be hurried or hindered according to the direction in which it passes through the water. This effect doubtless exists, but the results of it have never been detected by experiment. It is therefore necessary to inquire why the effect could not be observed directly, for the experiment had been tried with interference apparatus by Babinet, Hoek, Jamin, and Mascart, and in no case was any effect observed. It would therefore seem as if the ether must be stagnant, *i.e.* stationary relative to the earth. Mascart had also tested whether Newton's rings, or the rotary power of quartz, were affected by ether drift, but with negative results. These observations are, however, likewise compatible with Fresnel's hypothesis of an ether fixed relative to matter, and a free ether of space permeating all substances, for, according to this view, there is no more motion of the ether in water or glass than in air; hence the time of journey round a closed contour is independent of the direction in which the light traverses that contour. The time of journey between two points is also unaffected by terrestrial motion, as was proved by the experiments of Babinet, Hoek, and Mascart on interference; hence he (Dr. Lodge) inferred that ether was either stagnant or had a velocity potential. In moving ether it was necessary to define a ray, and Lorentz's method is the best. Suppose CP represents the velocity of




light (V) in still ether, and SC the velocity of the ether ($v$), then a disturbance originating at S will travel along SP, which is the

direction of the ray, whilst CP is the wave normal. In the above figure,

$$\frac{\sin\epsilon}{\sin\theta} = \frac{SC}{CP} = \frac{v}{V} = \alpha, \text{ the constant of aberration.}$$

The velocity along the path of the ray is SP. Calling this velocity V′, we have

$$V' = V\cos\epsilon + v\cos\theta.$$

The path of a ray is determined by the time of journey being a minimum, and the formula

$$T = \int_A^B \frac{ds}{V} = \text{a minimum},$$

is the equation to a ray, where A and B are the extremities, and $ds$ an element of the path. If the ether be moving, V′ must be substituted for V, and we get—

$$T' = \int_A^B \frac{ds}{V\cos\epsilon + v\cos\theta} = \text{a minimum}.$$

This integral can be written exactly—

$$T' = \int \frac{ds}{V}\frac{\cos\theta}{1-\alpha^2} - \int \frac{v\cos\theta}{V^2(1-\alpha^2)}ds$$
$$= \frac{T\cos\theta}{1-\alpha^2} - \int \frac{v}{V^2}\cdot\frac{\cos\theta}{1-\alpha^2}\cdot ds.$$

The last term is the only one involving the first power of ether drift, and it vanishes in case there is a velocity potential; for, since $v\cos\theta = \frac{d\phi}{ds}$, where $\phi$ is the velocity potential, it may be written $\frac{\phi_B - \phi_A}{V^2(1-\alpha^2)}$; and so its value depends only on the end points and not on the path. If these points are the same, *i.e.* the contour is closed, it becomes zero, and reconciles all the experiments hitherto made. It must be admitted, however, that if $\alpha$ is not a constant, the question is again opened, but there is no reason to suppose it can vary in the same horizontal plane. If the medium be changed, V becomes $\frac{V}{\mu}$, and, in order to retain the same velocity potential in the changed medium, $v$ must become $\frac{v}{\mu^2}$, which is Fresnel's law. Hence Prof. Lodge pointed out that the velocity potential condition includes Fresnel's law as a special case. It can, in general, be inferred that *no first order optical effect due to terrestrial motion can exist in a detectable form.* It is always compensated by something else. Quantities of the second order of magnitude must, therefore, be attended to. From the first equation above, it follows that

$$\cos\epsilon = \sqrt{1-\alpha^2\sin^2\theta},$$

and the time of journey in moving ether is given by

$$T' = T\frac{\sqrt{1-\alpha^2\sin^2\theta}}{1-\alpha^2},$$

where T is the time if everything were stationary. This is, in brief, the theory of Michelson's recent experiment. If the light travels along the ether drift, $\theta = 0$ and $T_1 = \frac{T}{1-\alpha^2}$; whilst if $\theta = 90°$, $T' = \frac{T}{\sqrt{1-\alpha^2}}$. Therefore the velocity along the ether drift should differ from that across the drift in the ratio of $\sqrt{1-\alpha^2} : 1$. This point has been very carefully tested by Michelson, but nothing approaching to a quarter of the theoretical effect was observed. His negative result would seem to preclude any relative motion, even irrotational, and shows that the ether is at rest relative to the earth's surface. On the other hand, the author (Dr. Lodge) had recently made experiments on the influence of rapidly-rotating steel disks on the ether, which prove that the ether is not affected by the motion of contiguous matter to the extent of 1/200 part of the velocity of the matter. Thus, these two experiments are at present in conflict. Prof. Fitzgerald has suggested a way out of the difficulty by supposing the size of bodies to be a function of their velocity through the ether. Returning to the statements which have been made of Fresnel's law, Glazebrook has shown that actual extra-density of ether is not necessary, for, if the virtual mass be altered, the same results follow; all that is required is a term depending on the relative acceleration of ether and matter. To modern ideas the loading of the ether by the presence of matter is most likely to be correct, and the observed effects of relative motion are regarded as the results of secondary reactions of matter on ether. On this view, the ether of space may be wholly unaffected by the motion of matter. On the vortex ring theory of matter, it is not unnatural to suppose that the ether in its neighbourhood should be only affected irrotationally by its motion. And if the velocity potential be granted, nothing of the nature of viscosity being admissible, the results of all the interference, refraction, and aberration experiments could be predicted, and the whole theory is as simple as it can possibly be. The only trustworthy experiment ever made which tends against this view is that of Michelson. The author surmised that this must somehow be explained away. In reply to a question from Prof. Ayrton, Dr. Lodge said that when air was substituted for water in Fizeau's experiment no effect was observed. This might have been expected, for the difference in the times of journey by the two paths depended on $\frac{\mu^2-1}{\mu^2}$, and as $\mu$ is nearly unity for air, the air effect is too small to see. [In Hoek's interference experiment it might be said that the effect of ether moving in stationary water is balanced by that of the ether moving in stationary air; but while motion of water itself would disturb the balance, motion of air would do nothing appreciable. The only kind of motion that could display an optical effect is rotational motion, or motion of layers at different speeds, not a simple uniform drift. Prof. J. V. Jones asked how the Fizeau experiment could be expressed on the loaded ether theory; for, since the speed of matter affects the velocity of light, it seemed to involve a directional loading. A mere extra-density term, or acceleration coefficient, will not explain this; it seems to require a coefficient of a velocity term. This question has been hinted at by Lord Rayleigh, who points out (under the heading "Aberration," NATURE, xlv. p. 499) that the rate of propagation of waves on a loaded string will be affected by a travelling of its load. The question is not perfectly simple, and the analogy not complete. A good deal depends on the nature of the connection symbolized as "loading."[1]]

**Royal Microscopical Society**, May 18.—Dr. R. Braithwaite, President, in the chair.—Mr. R. T. Lewis, in his paper on the process of oviposition as observed in a species of cattle tick, said that the tick was observed under a low power; after some time the head with the extended rostrum and palpi was retracted, producing a deep depression, the softer adjacent portions of the ventral surface between the basal joints of the first pair of legs being drawn over the margin. Parts surrounding the depression changed colour, and a white vesicle appeared upon the lower internal wall. The palpi separated, so that they rested on each side of the vesicle. A membranous body, glistening with mucus, was protruded from the cavity, from the lateral extremities of which two papillæ were thrown out, extending across the depression. The vesicle was then elongated and embraced by the papillæ; through its walls an egg was seen in motion, which, being delivered into the grasp of the papillæ, the ovipositor at once retracted. The papillæ closed round the egg, covering it with an albuminous secretion, and withdrew, leaving it suspended from the under surface of the dorsal plate. The palpi closed together until in contact with the rostrum, the head elevating, clearing the egg out of the depression, leaving it adhering to the outer margin; the entire process of laying each egg occupying a period of 2 min. 42 sec. Mr. A. D. Michael remarked that the word "head" was somewhat misleading, because these animals had no heads in the sense in which the term applied to insects, but the whole movable organ was really the rostrum.—Mr. E. M. Nelson read a note on penetration in the microscope, showing that for his own sight the penetrating power was only one-seventh of that given by Prof. Abbe, whose myopic sight accounted for the difference in the estimate.—Mr. Nelson also read a note on rings and brushes of crystals, for the observing of which a petrological microscope was generally thought to be necessary. This was not essential, as it was really a telescopic object. All that had to be done was to convert the microscope into a telescope by placing an objective inside the tube of the instrument.

**Geological Society**, May 25.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were

[1] Note by O. J. L.

read:—On *Delphinognathus conocephalus* (Seeley) from the Middle Karoo Beds, Cape Colony, preserved in the South African Museum, Cape Town, by Prof. H. G. Seeley, F.R.S. The skull described in this paper is believed by Mr. T. Bain to have been collected by himself near Beaufort West. The preservation of the specimen leaves something to be desired, but notwithstanding defects the skull belongs to a most interesting Anomodont, indicating a new family of fossil Reptilia. The skull is fully described in the paper, and its relationships are discussed. The author has already given reasons for regarding *Ælurosaurus felinus*, *Lycosaurus curvimola*, and their allies, as referable to a suborder *Gennetotheria*, which is nearly related apparently to the *Pelycosauria*, and lies midway between the typical *Theriodontia* and the *Dicynodontia*. It is to this suborder that *Delphinognathus* may be referred, though it forms a family-type distinct from the *Ælurosauridæ*, distinguished by the conical parietal with a large foramen, the anterior supracondylar notch in the squamosal bone, and other modifications of the skull and teeth.—On further evidence of *Endothiodon bathystoma* (Owen) from Oude Kloof, in the Nieuwveldt Mountains, Cape Colony, by Prof. H. G. Seeley, F.R.S. Two bones found by Mr. T. Bain at Oude Kloof consist of the left ramus of the mandible and what the author regards as the left squamosal bone of *E. bathystoma*. The small cranial fragment preserved shows that the cerebral region probably conformed to the type of skull seen in some of the Dicynodonts. A description of the remains is given, and the author notices that the form of the articular condyle indicates a difference from *Dicynodontia* and all other *Anomodontia* hitherto described; it implies an oblique forward inclination of the quadrate bone—a character important in defining the suborder *Endothiodontia*. All the characters of the dentition of the animal suggest near affinity with the *Theriodontia*, especially the long lanceolate teeth strongly serrated.—On the discovery of Mammoth and other remains in Endsleigh Street, and on sections exposed in Endsleigh Gardens, Gordon Street, Gordon Square, and Tavistock Square, N.W., by Dr. Henry Hicks, F.R.S. In this paper the author gives a description of the deposits overlying the loam in which the remains of the Mammoth and other animals were found in Endsleigh Street, N.W. Under about six feet of made ground there was about ten feet of a yellowish-brown clay containing flints and much "race." Below the clay there was about five feet of sand and gravel, and under this about one foot of clayey loam, in which most of the bones were embedded. This loam contained many seeds, recognized by Mr. Clement Reid as being those of plants usually found in marshy places or ponds, and having a range at present from the Arctic Circle to the South of Europe. A list of the bones found is given by Mr. E. T. Newton, of the Museum of Practical Geology, Jermyn Street, who describes them as being those of one full-grown Mammoth, of another about half-grown, of the Red Deer, the fossil Horse, and of a small rodent. The author gives sections through Endsleigh Street and along the southern side of Endsleigh Gardens, and shows that where the bones were found there was a distinct valley in the London Clay, running in a direction nearly due north and south, the inclination of the valley being towards the north. The London Clay reached nearest to the surface towards St. Pancras Church and in Upper Woburn Place, the total thickness of the overlying deposits and the made ground there being only about 12 feet. Other sections, given along the southern sides of Tavistock and Gordon Squares, and through Gordon Street and the western side of Gordon Square, show varying thicknesses of the deposits, overlying the uneven floor of London Clay, of from 16 to 21 feet; the greatest thickness here is found at the north-western corner of Gordon Square. Seeds were also discovered in a loam near the bottom of Gordon Street, at the same horizon as that containing the mammalian remains, and some shells were found in a band of sandy clay, under a calcareous deposit, about half-way down the western side of Gordon Square. The author says that the deposits above the mammaliferous loam overlying the London Clay in this area cannot be classed as post-Glacial river-deposits, but must be considered as of Glacial origin. The animals, therefore, which evidently died on the old land-surface where their remains were found, lived there early in the Glacial period. The reading of this paper was followed by a discussion, in which the President, Mr. Monckton, Sir Henry Howorth, and the author took part.—The morphology of *Stephanoceras zigzag*, by S. S. Buckman.

**Entomological Society**, June 1.—R. McLachlan, F.R.S., Treasurer, in the chair.—The Hon. Walter Rothschild sent for exhibition *Neptis mimetica*, n.s., from Timor, mimicking *Andasena orope*, one of the Euplœidæ, and *Cynthia equicolor*, n.s., a species remarkable for the similarity of the two sexes, from the same locality; also a hybrid between *Saturnia carpini* and *S. pyri*, and specimens of *Callimorpha dominula*, var. *romanovii*, var. *italica*, and var. *donna*, bred by a collector at Zürich; he further exhibited a very large and interesting collection of Rhopalocera made by Mr. W. Doherty in Timor, Pura, Sumba, and other islands, during October and November 1891. Colonel Swinhoe remarked that the various species of *Neptis* were usually protected and imitated by other insects, and did not themselves mimic anything, and that the pattern of the *Neptis* in question was very common among the butterflies in the Timor group. Mr. Jenner Weir, Prof. Meldola, Mr. Trimen, and others continued the discussion.—M. A. Wailly exhibited fertile ova of *Trilocha varians*, which are arranged in small square cells, fastened together in large numbers, and present an appearance quite different from the usual type of Lepidopterous ova.—Mr. F. Merrifield exhibited a series of *Drepana falcataria*, half of which had been exposed for a week or two, in March or April, to a temperature of about 77°, and the other half had been allowed to emerge at the natural out-door temperature. The latter insects were in all cases darker than the former, all being equally healthy. Mr. McLachlan, Mr. Barrett, Mr. Jenner Weir, and others took part in the discussion which followed.—Mr. McLachlan called attention to the reappearance in large numbers of the Diamond-back Moth, *Plutella cruciferarum*, which was very abundant in gardens near London, and expressed his opinion that the moths had been bred in the country and had not immigrated.—Mr. Jenner Weir, Mr. Bower, and Prof. Meldola stated that they had recently seen specimens of *Colias edusa* in different localities near London.—The Hon. Walter Rothschild communicated a paper on two new species of *Pseudacræa*.

CAMBRIDGE.

**Philosophical Society**, May 30.—Prof. G. H. Darwin, President, in the chair.—The following communications were made:—The hypothesis of a liquid condition of the earth's interior considered in connection with Prof. Darwin's theory of the genesis of the moon, by Mr. Osmond Fisher. It was contended that a liquid condition of the earth's interior is not negatived by the existence of a semi-diurnal ocean tide, because it appears by calculation that a tide in an equatorial canal would in that case be diminished by only one-fifth of what its height would be upon a rigid earth. It was then recalled that all Prof. Darwin's numerical results in Table IV. of his paper on the precession of a viscous spheroid, as for instance that the moon was shed from the earth about 57 millions of years ago, depend upon the assumption of a certain high value for the internal viscosity, and will not hold good for a liquid interior. The total amount of heat, however, which must have been generated since that event, does not depend upon the viscosity, and will have been the same in the case of a liquid interior. This, if applied all at once, Prof. Darwin says, would raise the whole earth through 3000° F. if it had the specific heat of iron. Lord Kelvin holds that the earth is solid, and that it solidified in a short space of time, and that the matter of the interior at every depth is at the temperature of solidification for the pressure there. But if heat is being continually communicated to the interior, and chiefly to the more central regions, it seems impossible that the state of solidity supposed could be maintained. The author has shown in his "Physics of the Earth's Crust" that, if the crust is as thin as many geologists suppose, then there must exist convection currents in the interior, which prevent the crust from growing thick by melting off the bottom of it nearly as fast as it thickens. The central heat imparted to the interior by tidal action explains the maintenance of such currents. But the difficulty arises that the heat generated has been so great that there seems no obvious adequate mode of getting rid of it. The heat conducted away through the crust would not have been sufficient to reduce the mean temperature of the globe by more than about 209° F. in 100 million years from the first formation of a crust. Volcanic action on an extravagant estimate would help only to the extent of 4° or 5° F.; and the work of deformation of the crust would account for still less. It appears from the above that, if Prof. Darwin's theory is true, the solidification of the

crust cannot have commenced until long after the birth of the moon; so that the still molten surface would be able for ages to radiate its heat directly into space. Otherwise we are thrown back on the nebular hypothesis, according to which the moon was left behind in the process of evolution of the system.—On Gynodiœcism in the Labiatæ, by Mr. J. C. Willis. Among the hermaphrodite flowers of *Origanum* and other Labiatæ, there occur (on the *same* plant) female flowers, and also flowers with one or more imperfect stamens; the corollas of these flowers are usually smaller than those of normal hermaphrodites. Their number varies from ·1 to 7·5 per cent. of the total flowers. Experiments conducted in 1891, to determine if these abnormalities varied in number with the season, gave no result; no two plants (though all were from one stock) gave similar results. Observations were also made on *Nepeta Glechoma;* the relative numbers of female and hermaphrodite flowers were determined weekly during the flowering season, and the proportion of females found to be greatest at the beginning of the season. It was also noticed that the female plants bear more open flowers at one time than the hermaphrodites (3·1 to 2·1). It was observed that the amount of protandry in the flowers appears to vary, being small at the beginning, and larger towards the end of the season. Further observations are in progress upon this subject.—On the steady motion and stability of dynamical systems, by Mr. A. B. Basset.—Note on the geometrical interpretation of the quaternion analysis, by Mr. J. Brill. The last two papers were taken as read.

DUBLIN.

**Royal Dublin Society,** May 18.—Dr. G. J. Stoney, F.R.S., Vice-President, in the chair.—Mr. G. H. Carpenter presented a report upon the Pycnogonida collected in Torres States by Prof. A. C. Haddon. The collection comprises only three species: *Pallene australiensis*, Hoek, for which (together with a new species) a new genus (*Parapallene*) is suggested; and a new *Ascorhynchus*.—Mr. H. H. Dixon gave a preliminary note on the mode of walking of some of the Arthropoda, illustrated by means of instantaneous photographs. He found that the limbs move together in "diagonals"; in insects the first and third legs on one side move with the second on the other; in spiders the first and third on one side with the second and fourth on the other; while the antenna of an insect is moved with the first leg on the same side.—Sir Howard Grubb, F.R.S., described his new chronograph for the Cape Town Observatory. This chronograph is built on the model of that at Dunsink Observatory, Dublin, with such improvements as have been suggested by recent developments in the clock-work of equatorial telescopes. The barrels, two in number, either or both of which can be brought into action, are 28 inches long and 9 inches in diameter. The screws which carry the wagons are one-tenth pitch, revolving once per minute. The circumference of the barrel being about 27 inches, the seconds are four-tenths of an inch long, and each barrel is available for about four and a half hours' work. The principal modifications upon the Dunsink instrument consist in the application of the electrical control of the clock, as described in the Proceedings of the Institution of Mechanical Engineers for the year 1888. The governor shaft of the clock gears directly into the driving spindle without any intermediate wheels, and as there is maintaining power to the clock barrel, it is possible to wind during the operation without at all affecting the rate of the clock. The axes of the barrels are supported upon sets of bicycle balls, in hardened steel boxes. The wagons carrying the electro-magnets for the registration of the signals are carried on one plain roller and two grooved rollers, the latter having hardened steel end-plates to insure accuracy of position. With the main instrument, which is inclosed in a glass case, is supplied a distributor for the purpose of working the electrical control, for the explanation of the action of which the above paper may be referred to.—On a new electrolytic galvanometer, by J. Joly. In the ordinary methods of determining the strength of a current by means of electro-chemical action, the element of time enters into the measurements, which further require considerable care in carrying out. In this instrument the observer is not concerned with time observations, and its indications follow fairly rapid variations of current. It consists of a glass bulb containing dilute sulphuric acid, in which are immersed platinum electrodes placed close together to diminish resistance. This vessel communicates below with a tube bent twice at right angles and carried up to a height of about 50 cm. above the level of the bulb. A little mercury contained in the bulb rises normally into this tube to a level which is the zero of the instrument. The tube is open at the top. The bulb is furnished with two tubulures on its upper surface. One is kept closed by a stopper, and merely serves to admit the electrolyte into the bulb when filling it. The other is furnished with a brass attachment upon which is cemented a small piece of platinum foil pierced by a hole of very small bore. The puncture is protected above and below from obstruction by receptacles containing cotton wool. When a current is passed between the electrodes the gas evolved can only escape through the fine puncture. At normal pressures this will only let the gas pass out slowly. Hence there is an accumulation of gas in the bulb, and the increased pressure causes the mercury to rise in the vertical index tube; but as the pressure rises, the rate of efflux of the gas increases till it equals the rate of evolution, when the mercury column comes to rest. The reading of a scale alongside the tube then gives the current in amperes. The instrument constructed for trial is very satisfactory. It reads on a very open scale up to 2·5 amperes. The electrodes are not large enough to carry heavier currents; if they were so, of course by enlarging the orifice the range could be increased. At the higher readings there is some delay before the mercury column becomes stationary, due probably to a rise of temperature in the bulb. There is probably some small variation of the readings with atmospheric temperature change. The calibration is effected by placing it in circuit with a trustworthy galvanometer. The inventor has had but little leisure to develop the instrument, and brings it before the Society in hopes that someone may think it worth while to further investigate its capabilities.

PARIS.

**Academy of Sciences,** June 7.—M. d'Abbadie in the chair.—On the application of M. Linstedt's method to the problem of three bodies, by M. H. Poincaré.—On a class of analytical functions of one variable dependent on two real arbitrary constants, by M. Emile Picard.—On the products of the residual life of the tissues, especially of the muscular tissue separated from the living being, by MM. Gautier and Landi (continued). The authors found that meat when kept at a temperature not exceeding that of the living animal, acquired an acidity of about 0·5 per cent. after several weeks, during which it was protected from air and bacteria. They attribute this acidity to the formation of acid phosphate of potassium under the influence of fatty acids, and especially to the partial peptonization of the albuminoids. Two substances, found in milk, but not in fresh meat, are also abundantly produced, viz. casein and nucleo-albumin. The albuminoids steadily decrease, whereas there is a proportional increase of alkaloids, these being identical with those produced during the life of the organism.—Effects produced upon numerous morbid states by subcutaneous injections of a liquid extract from the testicles, by M. Brown-Séquard.—On the densities of liquefied gases and their saturated vapours, and on the constants of the critical point of carbonic acid, by M. E. H. Amagat.—On new methods of forming certain substitution imides, by M. A. Haller.—Reports of the Committee charged with the examination of the calculator Inaudi, by MM. Charcot and Darboux. Jacques Inaudi, a peasant born in Piedmont in 1867, learned to reckon before he acquired the art of reading and writing, which he did not master till twenty. He therefore owes his extraordinary calculating powers to an abnormally developed memory for figures, aided by a mental representation of numbers which the Committee proved by a series of careful experiments to be purely acoustical, and quite independent of visualization. The rules of Inaudi's operations are original. In addition and subtraction he begins on the left side, and deals with each whole number in its turn. The extraction of roots and the solution of equations are performed by tentative approximations, executed with remarkable rapidity. At the end of a long sitting Inaudi was able to recount the whole series of numbers dealt with, amounting to some 400 figures.—On the stability of motion in a particular case of the problem of three bodies, by by M. Coculesco.—Solar observations during the first quarter of the year 1892, by M. Tacchini. At the Roman College, during this period, the frequency of metallic eruptions, spots, and faculæ was greater in the southern hemisphere of the sun, whereas the protuberances were more frequent in the northern, and nearer the pole. The auroral maximum is probably more dependent

on that of the protuberances than that of the sun-spots.—On a property common to three groups of two polygons, inscribed, circumscribed, or conjugate to one conic, by M. Paul Serret.—On di-continuous groups of non-linear substitutions with one variable, by M. Paul Painlevé.—On the acceleration of mortality in France, by M. Delauney. From a calculation based upon certain tables published by the Bureau des Longitudes, it appears that the death-rate is accelerated during the ages ranging from 16 to 32 and 54 to 82, while it is retarded between 1 and 16, 32 and 54, and after 82. This gives the numbers 16, 32, 54, and 82, which may be regarded as natural epochs of human life. They may be derived from the equation $3x^2 - 5x + 4$, by substituting for $x$ the values 3, 4, 5, and 6. The equation represents a parabola.—Optical method of determining the conductivity of metallic bars, by M. Alphonse Berget. This is based upon an application of interference fringes or Newton's rings produced at the ends of two bars to be compared, by means of which the ratio of their elongations is found. Applicable to bars of rare metals.—On the propagation of heat within crystallized substances, by M. Ed. Jannettaz.—On a new determination of the ratio $v$ between the electro-magnetic and the electrostatic C.G.S. units, by M. H. Abraham. Obtained by measuring the same capacity—of a plane condenser with guard ring—in both systems. The value obtained for $v$ was $299{\cdot}2 \times 10^9$.—On the basic nitrates of zinc, by M. J. Riban.—On the permolybdates, by M. E. Péchard.—On a reproduction of leucite, by M. A. Duboin.—Contributions to the study of mineral waters: preservation of these waters, by M. P. Parmentier.—On the fixation of iodine by starch, by M. Gaston Rouvier.—Mechanical determination of the boiling-points of alcohols and acids, by M. G. Hinrichs.—Preparation and heat of formation of monosodic resorcin and hydroquinone, by M. de Forcrand.—Thermal study of the dibasic organic acids: methyl-malonic and methyl-succinic acids; influence of isomerism, by M. G. Massol.—On an oxidation product of starch, by M. P. Petit.—Organo-metallic combinations of the aromatic acetones, by MM. E. Louise and Perrier.—On the chlorine derivatives of the isobutylamines, by M. A. Berg.—Researches on the ptomaines in some infectious diseases, by M. A. B. Griffiths.—On the dioptase of the French Congo, by M. E. Lacroix.—Researches on the filtration of water by the Mollusca, and applications to ostreiculture and oceanography, by M. H. Viallanes.—On a parasite of the locusts, by M. L. Trabut.—Tuberculous vaccination of dogs, by MM. Héricourt and Ch. Richet. The effect was tried of vaccinating some dogs with aviary tuberculosis, which proved a perfect prophylactic to human tuberculosis, the injection of which proved fatal to those not so vaccinated, the rest being unaffected.

BERLIN.

**Physiological Society**, May 13.—Prof. Munk, President, in the chair.—Prof. Loewy gave an account of experiments on respiration under reduced atmospheric pressure, carried out in a confined space which admitted of very rapid reductions of pressure (to half an atmosphere) with constant composition of the inclosed air. The amount of reduction which was borne without ill effects differed in the case of the three persons on whom the experiments were made, in accordance with the magnitude of their respiratory activities: the greater the latter, the greater was the reduced pressure which could be withstood. For any one person it appeared that a greater reduction could be borne while fasting or during work than after a meal or during repose. Both oxygen and carbon dioxide were found to do away with the discomfort resulting from over rarefaction of the air. Slightly reduced pressure had no effect on respiratory interchange, while if the reduction was considerable, more carbon dioxide was expired, notwithstanding the diminished supply of oxygen. The reduced pressure of the latter gas was found to act on the respiratory mechanism in such a way as to lead to deeper, and hence compensatory, respiratory movements.—Dr. Wertheim spoke on the blood-vessels of the avian eye in both the embryonic and fully developed state, illustrating his remarks by injected specimens of embryonic eyes.

**Physical Society**, May 20.—Prof. Lampe, President, in the chair.—Prof. Neesen gave an account of his researches on the motion of loose disks centred on an axis rotating at high speeds. The disks were of varying mass and moment of inertia, and had at one side an excentrically-placed pin, in order that the least weight might be determined which, when applied to this pin, stopped the rotation of the disk. The necessary weight, as thus measured, was found to vary with the rotational velocity of the axis and with the mass and moment of inertia of the disk. It varied also according as the axis was dry or smeared with old or new oil, and also with the material of which the disk was made, &c.—Dr. Wien spoke on Maxwell's electro-magnetic theory, and the additions made to it by Poynting, and gave, in conclusion, a hypothetical conception of the nature of magnetism which corresponded to the existing formulæ.

## BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Notes and Queries on Anthropology, second edition: edited by J. G. Garson and C. H. Read (Anthropological Institute).—The Birds of the Sandwich Islands, Part 3: S. B. Wilson and A. H. Evans, (Porter).—Irrigation and Water Storage in the Arid Regions; Letter from the Secretary of War (Washington).—Die Grundzüge der Theorie der Statistik; Prof. H. Westergaard (Jena, Fischer).—Die Bewegung der lebendigen Substanz: M. Verworn (Jena, Fischer).—Ostwald's Klassiker der Exakten Wissenschaften, Nos. 1 to 30 (Leipzig, Engelmann).—The Threshold of Science, second edition: Dr. C. R. A. Wright (Griffin).—Untersuchungen über mikroskopische Schäume und das Protoplasma: O. Bütschli (Leipzig, Engelmann).—Die Epiglottis: C. Gegenbaur (Leipzig, Engelmann).—Jethou, or Crusoe Life in the Channel Islands: E. R. Suffling (Jarrold).—Six Botanical Diagrams (S.P.C.K.).—Essays upon Heredity and Kindred Biological Subjects: Dr. A. Weismann; edited by E. B. Poulton and A. E. Shipley; vol. ii. (Oxford, Clarendon Press).

PAMPHLETS.—Present Problems in Evolution and Heredity: Prof. H. F. Osborn.—Church and State in Early Maryland: Dr. G. Petrie (Baltimore).

SERIALS.—Journal of the Marine Biological Association, vol. ii., No. 3 (Dulau.)—Proceedings of the American Philosophical Society, vol. xxx., No. 137 (Philadelphia).—Proceedings of the Academy of Natural Sciences, Philadelphia, 1892, Part i. (Philadelphia).—Transactions of the Leicester Literary and Philosophical Society, April (Leicester).—Rendiconto dell' Accademia delle Scienze Fisiche e Matematiche, January to March (Napoli).—Proceedings of the Royal Society of Victoria, vol. iv. (new series), Part i. (Williams and Norgate).

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